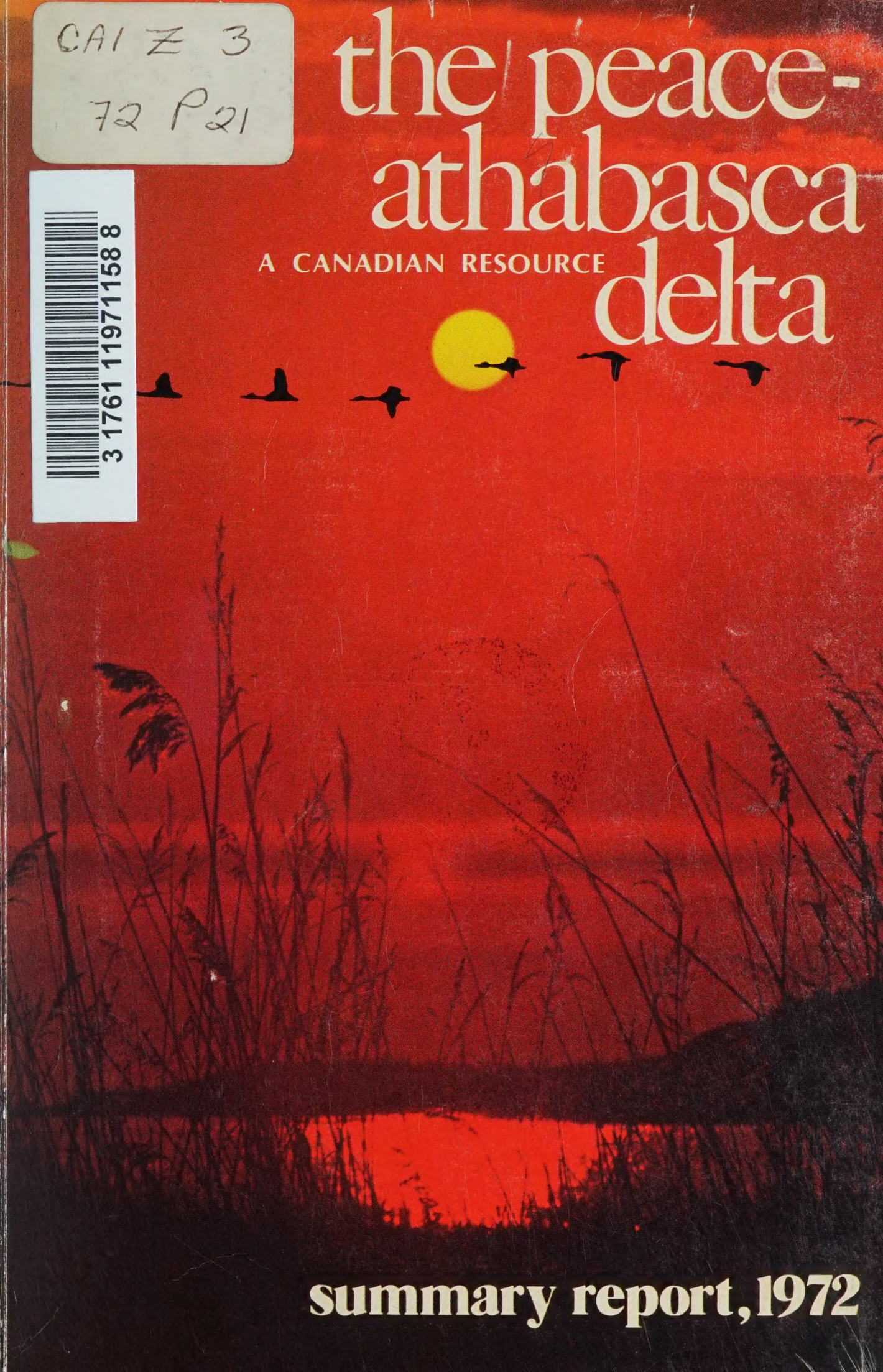
CA1 Z 3
72 P21

3 1761 11971158 8

the peace-athabasca delta

A CANADIAN RESOURCE



summary report, 1972



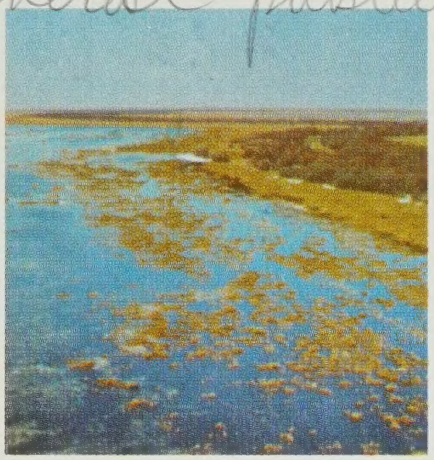
A co-operative intergovernmental study established by the Environmental Ministers of Canada, Alberta and Saskatchewan

Honourable W. J. Yurko
for
Alberta

Honourable Jack Davis
for
Canada

Honourable N. E. Byers
for
Saskatchewan

[Canada] Peace - Athabasca Delta
Project Group
[General publications]
Government Publications
CA1 Z3
72 P21



[G-4]

the peace-athabasca delta

A CANADIAN RESOURCE

This is remote country

This is beautiful country

This is rich country

This is what Canada is all about

A REPORT ON LOW WATER LEVELS IN LAKE ATHABASCA AND THEIR EFFECTS ON THE PEACE-ATHABASCA DELTA

Prepared by The Peace-Athabasca Delta Project Group
Canada · Alberta · Saskatchewan

CONTENTS

Introduction	Page 3
1. The Setting	Page 7
2. The Peace-Athabasca Delta	Page 15
3. The Region and Its People	Page 37
4. A Perspective on Two Regional Assets	Page 55
5. Low Water Levels and Their Impact	Page 65
6. Remedial Alternatives	Page 91
7. The Legal Framework	Page 111
8. Government Co-ordination	Page 121
9. The Peace-Athabasca Delta Project	Page 127
10. Recommendations	Page 137
In Conclusion	Page 144

ACKNOWLEDGEMENTS

The Project Group wishes to acknowledge the assistance and co-operation of all the individuals and agencies who contributed to the Peace-Athabasca Delta Project. Special mention is made of Ducks Unlimited (Canada), which supplied both personnel and financial assistance from the private sector.

Appreciation is due Chief Albert Gladue of the Cree Band, Chief Fred Marcel of the Chipewyan Band, Mr. Frank Ladouceur of the Metis Association, and other local residents who contributed their intimate knowledge of Lake Athabasca and the Peace-Athabasca Delta.

The Project Group expresses sincere sympathy to the families of Mr. Gerald Maaskant and Mr. Terrence Massey, who lost their lives in a helicopter accident, March 18, 1971, while working on the Project.



introduction

For the first time in the 10,000 years or more of its existence, the Peace-Athabasca Delta became the focus of widespread public attention in the spring and summer of 1970. After several successive years of reduced seasonal flooding, this little-known but valuable Canadian wetlands resource appeared to be in imminent danger of drying out. Observers were convinced that an "ecological disaster" was in the making. It seemed certain that the wildlife was threatened with severe depletion, and with it the main livelihood of the many native people who fished and trapped in the area. As public concern mounted, it became evident that a detailed assessment of the situation was necessary.

The Peace-Athabasca Delta is one of the world's largest fresh-water deltas, a rich one-and-one-half-million-acre boreal landscape that was once a part of Lake Athabasca. Historically, the productivity of its wetlands has been almost entirely dependent upon the varying water levels of this lake.

Commencing in 1968, Lake Athabasca water levels were low for several successive years and rapid changes began to occur in the ecology of the Delta. Although similar changes had occurred in years of naturally low water levels in the lake, these conditions had apparently always before been reversed by succeeding years of high water levels and the resultant flooding of the Delta. It now appeared that the recently constructed Bennett Dam on the Peace River in British Columbia was directly responsible for the reduction in Lake Athabasca water levels. If this were so, the possibility of naturally rising water in succeeding seasons was extremely doubtful. The prospect of continuing damage to the Delta, to its wildlife, and consequently to the life of its people was disturbing indeed. Many concerned Canadians called for government action.

It was in response to this concern and the demand for action that the Peace-Athabasca Delta Project was created. Since Lake Athabasca lies in both Saskatchewan and Alberta, its levels influenced by the flows on the Peace River, originating in British Columbia, and because a major portion of the Delta is situated in Wood Buffalo National Park, it was essential that any assessment of the Delta situation be intergovernmental in nature. In January of 1971, the governments of Canada, Alberta and Saskatchewan established a co-operative interdisciplinary study group to investigate and report on the extent of low water levels in Lake Athabasca, their cause and their effect on the Delta

and upon the local people. This report outlines the findings and recommendations of the study.

The problem to be studied was extremely complex. The knowledge and talents of several scientific disciplines were required to bring together all existing information bearing upon the central inquiry. The contributions of many technical researchers were necessary to explore all facets of the problem.

Several areas of study were undertaken. Complex hydrological investigations were conducted to determine the relationship of the water levels of Lake Athabasca to the flows in the Peace River and to define the true cause of the drop in water levels. A full-scale ecological study was undertaken to ascertain the changes wrought by low water on the plant communities and on the habitats of fish and wildlife of the Delta. Social and economic studies were designed to assess the impact of the changes in water levels on the income and life-style of the local people, and upon navigation and water transport in the region. A legal and jurisdictional study was conducted to evaluate the existing legislative framework.

The report begins with a description of the setting of Lake Athabasca, the hydrology and ecology of the Delta and a profile of the people who live in this region. The national and regional importance of the Delta is illustrated. The low water levels since 1968, and their effects on the area are described, and long-term or future effects of these changes are outlined. Alternative solutions for the restoration of water levels are presented. Discussions of the legal framework, governmental co-ordination, and the Peace-Athabasca Delta Project organization round out the report. The final pages summarize the recommendations emanating from the study.

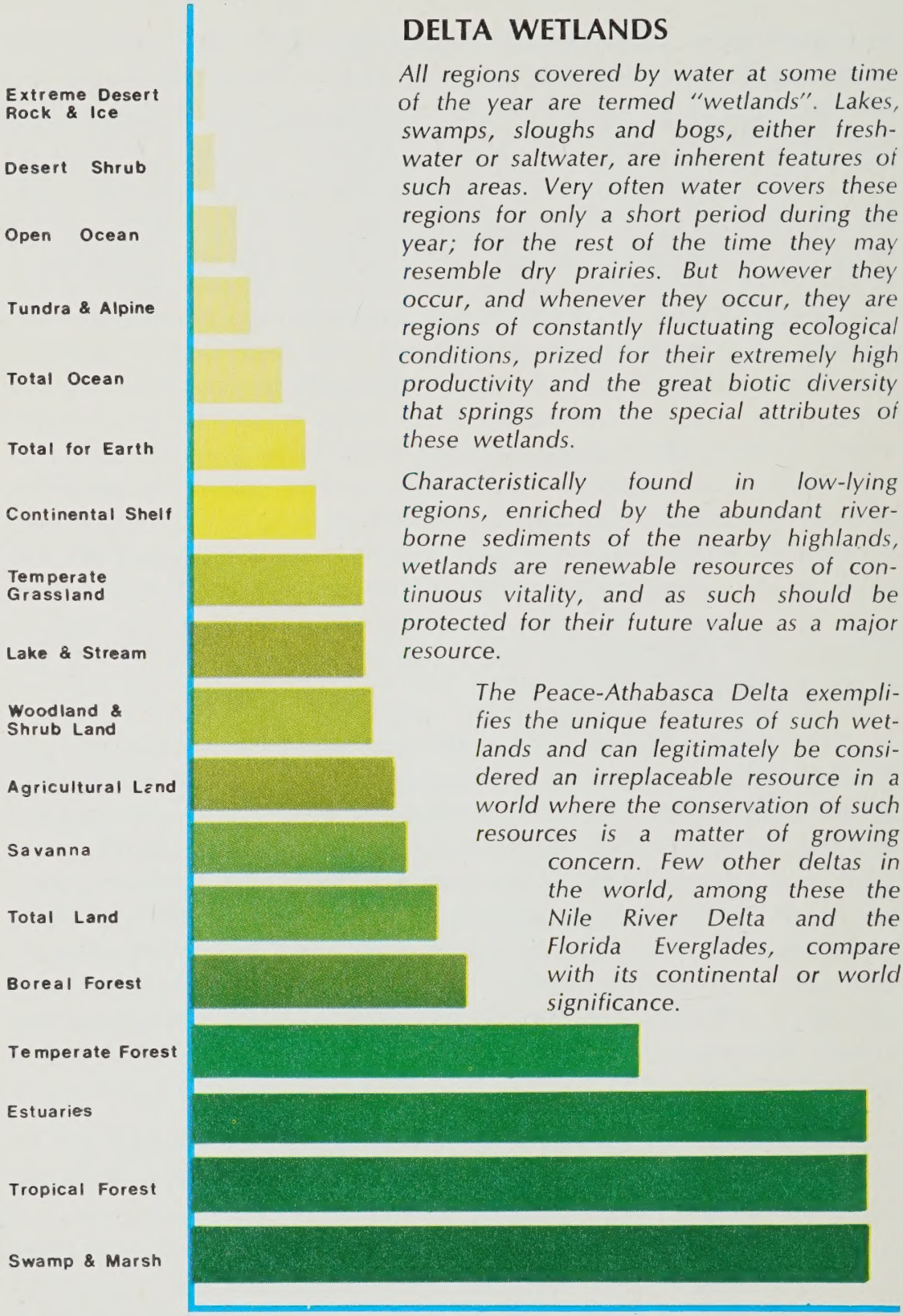
In these pages the reader will find a condensation of all information and conclusions upon which any decision for action will be based.

DELTA WETLANDS

All regions covered by water at some time of the year are termed "wetlands". Lakes, swamps, sloughs and bogs, either freshwater or saltwater, are inherent features of such areas. Very often water covers these regions for only a short period during the year; for the rest of the time they may resemble dry prairies. But however they occur, and whenever they occur, they are regions of constantly fluctuating ecological conditions, prized for their extremely high productivity and the great biotic diversity that springs from the special attributes of these wetlands.

Characteristically found in low-lying regions, enriched by the abundant river-borne sediments of the nearby highlands, wetlands are renewable resources of continuous vitality, and as such should be protected for their future value as a major resource.

The Peace-Athabasca Delta exemplifies the unique features of such wetlands and can legitimately be considered an irreplaceable resource in a world where the conservation of such resources is a matter of growing concern. Few other deltas in the world, among these the Nile River Delta and the Florida Everglades, compare with its continental or world significance.



RELATIVE PRODUCTIVITY OF LAND

It has been proven that wetlands, particularly those with diversity of character, are many more times valuable, from the standpoint of biological production, than farm, forest or range.



the setting

one

LAKE ATHABASCA

In the age-long drama of the recurrent summer flooding of the Peace-Athabasca Delta, the leading role is played by Lake Athabasca, with a supporting cast of three major rivers, the Athabasca, the Fond du Lac and the Peace. A 200-mile-long lake straddling the Alberta-Saskatchewan border, Lake Athabasca is one of the largest lakes in the vast Mackenzie River drainage system. Its major function in this 690,000 square-mile network, which drains more than half of Canada's arctic watershed, is the regulation of inflowing waters from the Athabasca and Fond du Lac Rivers. During flood periods it has often stored several million acre-feet* of water from its tributaries.

The Athabasca River, originating in the glacial dome of the Rocky Mountain Columbia Icefields, wends its way northeast for 800 miles across the Province of Alberta to Lake Athabasca. Commencing as a rapid mountain stream, it gradually matures as it picks up tributaries, until, at the point it enters Lake Athabasca it carries waters from a drainage area of approximately 60,000 square miles.

In the years between 1957 and 1969, the Athabasca Basin contributed an average of 17,000,000 acre-feet of water annually into Lake Athabasca. From typical winter flows of approximately 6,000 cubic feet per second between December and the end of March, the Athabasca River usually rises to about 50,000 cubic feet per second during June and July. In July of 1971 a peak flood flow of 165,000 cubic feet per second was recorded.

The Fond du Lac River, draining 32,000 square miles of the Canadian Shield, rises in Wollaston Lake, Saskatchewan, near the Manitoba border. This basin has annually contributed an average of 8 million acre-feet of water to Lake Athabasca. The Fond du Lac, its flow regulated by several lakes through which it passes on its way to Lake Athabasca, discharges at a relatively constant rate of about 11,000 cubic feet per second through much of the year, increasing to 15,000 cubic feet per second in the summer months.

* One acre-foot is a volume represented by one acre in area and one foot in depth.


PEACE-ATHABASCA DELTA
PROJECT FOCUS
Produced by Mapping Office, Surveys Branch, Department of Highways and Transport, Edmonton, Alberta.
ALASKA
YUKON TERRITORIES
NORTHWEST TERRITORIES
VICTORIA ISLAND
Porcupine
Arctic Red River
Fort McPherson
Tuktoyaktuk
Inuvik
Aklavik
Cape Parry
Parry Peninsula
Wollaston Peninsula
Fort Good Hope
Norman Wells
Coppermine
Bathurst Inlet
Dawson
Mayo Landing
Keno Hill
Ross River
WHITEHORSE
Carcross
Teslin
Watson Lake
Fort Norman
Fort Franklin
DISTRICT OF MACKENZIE
MACKENZIE RIVER
Rae
YELLOWKNIFE
Fort Providence
Fort Reliance
Snowdrift
Fort Liard
Rocher River
Fort Resolution
Hay River
Pine Point
DRAINAGE BASIN
WOOD BUFFALO NATIONAL PARK
Fort Vermilion
Fort Chipewyan
Uranium City
Eldorado
Fond-du-Lac
Stony Rapids
W.A.C. BENNETT DAM
Fort St John
Dawson Creek
Grimshaw
Peace River
Spirit River
Grande Prairie
Fort McMurray
Prince George
Quesnel
BRITISH COLUMBIA
ALBERTA
SASKATCHEWAN
Fort Saskatchewan
EDMONTON
Edson
Drayton Valley
Jasper
ELK ISLAND NATIONAL PARK
Vegreville
Vermilion
Camrose
Wetaskiwin
Ponoka
Lacombe
Red Deer
Wainwright
Stettler
Meadow Lake
PRINCE ALBERT NATIONAL PARK
Lloydminster
Prince Albert
Nipawin
Flin Flon
Lynn Lake
Churchill Lake
Lake Athabasca
Great Slave Lake
Great Bear Lake
Great Slave Lake
Lac la Martre
Contwoyto Lake
Coronation Gulf
Amundsen Gulf
Mackenzie
Liard
Peace
Athabasca
Slave
Hay
Smoky
Wabasca
Churchill
Beaver
Saskatchewan
Jasper National Park
Robson 12,972 ft.
Mount Robson Provincial Park
Kootenay National Park
Yoho National Park
Glacier National Park
Banff National Park
140°
130°
120°
110°
70°
65°
60°
55°
20°



J. CARD PHOTO

The Athabasca River, at this point, overflows its banks into the Embarras River during flood stages.

The Peace River has its source in the Rocky Mountains of British Columbia. From Williston Lake, the reservoir created by the W.A.C. Bennett Dam, it flows some 700 miles to its Delta north-west of Fort Chipewyan in Alberta. Here the river flows east, adjacent to its delta, joining with the Rivière des Rochers which drains Lake Athabasca, to form the Slave River.

These and other rivers tributary to Lake Athabasca add an annual volume of some 36.5 million acre-feet of water to the Lake. This makes it one of the major reservoirs in the Mackenzie system and the prime factor in determining the water levels of the Peace-Athabasca Delta at its west end.

In addition to its hydrological importance, Lake Athabasca is the key feature of the region that has grown out of, and is greatly dependent on, the water transportation system of this part of the Mackenzie basin.



GOVERNMENT OF ALBERTA PHOTO

The Peace River is joined by the Smoky River, at the left, on its way to the Delta.

At the confluence of the Peace, Slave and Rochers Rivers, the waters of the Athabasca join the Mackenzie River system via the Rochers.



GOVERNMENT OF ALBERTA PHOTO


PARK ROAD
FROM FT. SMITH
Carlson Landing
Pt
Providence
Sweetgrass Landing
P E A C E
River
CLAIRE
RIVER
Baril
L A K E
C L A I R E
Spruce Pt
Hdda
Lake
N A
BIRCH
RIVER
Willow
Pt
Pointe de Roche
P A R K
Welstead
L
Modere
River


PEACE - ATHABASCA DELTA
THE STUDY AREA
MILES
5 0 5 10
LIMIT OF DETAILED STUDY AREA CONTAINING 1.5 MILLION ACRES
BARGE ROUTE
CHIPEWYAN INDIAN RESERVE
PARK BOUNDARY
Rapids
Shelter Pt
Bustard Island
Pte Basse
LAKE ATHABASCA
Fort Chipewyan
Grouse Cape
Pine I
High I
English
Lobstick
Potato
Mouse I
Goose I
Big Pt
Quatre Fourches
MAMAWI LAKE
I.R. 201B
CHIPEWYAN INDIAN RESERVE 201
Embarras Portage
I.R. 201C
I.R. 201D
I.R. 201E
Richardson Lake
Henrietta L
Paxton L
ATHABASCA RIVER
BUFFALO
IONAL

LOCATION OF THE PEACE-ATHABASCA DELTA

The Peace-Athabasca Delta, situated largely in Wood Buffalo National Park, is located at the west end of Lake Athabasca. It lies west of the Canadian Shield, bounded by the Birch Mountains in the southwest, and by the Caribou Mountains in the northwest. The Delta, 1,475 square miles in area, is formed by three smaller deltas: the 760-square-mile Athabasca Delta, the Peace Delta of 650 square miles, and the Birch of 65 square miles. The most significant of the three, the Athabasca River Delta, has gradually spread over a vast area and filled the west end of Lake Athabasca. The Athabasca Delta now extends across the end of the lake, forming Lake Mamawi and creating the southerly and easterly shores of Lake Claire, a former bay of Lake Athabasca. The Peace Delta lies between Lakes Claire and Mamawi and the Peace River. On the west side of Lake Claire is the delta of the Birch.

THE DETAILED STUDY AREA

The area studied in detail covers some one and one-half million acres and is roughly delineated by a line running south to north through Bustard Island, east to west just north of the Peace-Rivière des Rochers confluence, north to south several miles west of Lake Claire, and west to east, south of Richardson Lake. Within the limits of this area, the Peace-Athabasca Delta Project Group has conducted comprehensive studies to assess the ecological effects of low water levels on the Delta and the subsequent impact of these effects on the residents of the area.

Environment Canada / Environnement Canada

Environmental Management / Gestion de l'environnement

Your file / Votre référence

Our file / Notre référence

Peace-Athabasca Delta Project - Summary Report

The enclosed Summary Report on the Peace-Athabasca Delta Project is sent to you with the compliments of Environment Minister Jack Davis.

This Report deals with an increasingly important subject-- how changes in environment may be brought about by activities which are carried on hundreds of miles away, and over which the people most affected have no control. It is highly desirable that complex relationships such as those described in this Report be widely understood, so that in the future, problems of this nature may be avoided or minimized.

The Report may be useful as a reference text for high schools as well as for educational programs carried out by government and industry. Additional copies of "The Peace-Athabasca Delta" may be obtained from the following sources:

Information Canada, 171 Slater Street, Ottawa K1A 0S9;

Queen's Printer, Province of Alberta, Edmonton, Alberta;

Queen's Printer, Province of Saskatchewan, Regina, Saskatchewan;

Price is $1.

A. T. Prince,
Director General,
Inland Waters Directorate,
Environment Canada.

EMS-1004



the peace-athabasca delta

two

THE NATURE OF THE DELTA

What, exactly, is a delta? The word, by no means unfamiliar, calls to mind a vague picture of a roughly triangular area of rich river-borne soil, netted with streams and dotted with marshes, at the mouth of a large river. Seldom do we ponder the manner of its evolution.

Actually, a delta is formed at the point where a river enters a lake or a sea. The fast-running water of the river suddenly loses velocity as it enters the larger body of water, allowing the suspended particles of silt and sand carried along in its current to drop and settle to the bottom. Gradually, as layer after layer of this sediment is deposited at the mouth of the river, the lake bottom builds up to the water surface. Bars, islands and peninsulas emerge, to divide the river here into a series of fingerlike channels which meander across the new delta plain. Plants colonize almost immediately on the exposed surface and their presence hastens the accumulation of sediment as flooding waters slacken their pace in passing over and around these islands of vegetation. The variations in rates of sediment build-up in different parts of the delta eventually result in the formation of numerous depressions of the delta surface, known as perched basins.

One of the largest fresh-water deltas in the world, the Peace-Athabasca Delta was born of the Pleistocene ice sheet as it receded from the west end of Lake Athabasca. Evolving over thousands of years, as annual deposits of silt and soil were laid down by the Peace and Athabasca Rivers flowing into Lake Athabasca, it has developed into a complex ecological area of one and one-half million acres.

The portion of the Peace-Athabasca Delta formed by the Peace River grew very rapidly as the river deposited its sediment down through the ages, until now the river is contained within its delta banks, except during the flood season. Only then does the Peace River carry new sediment over the Delta. In contrast,



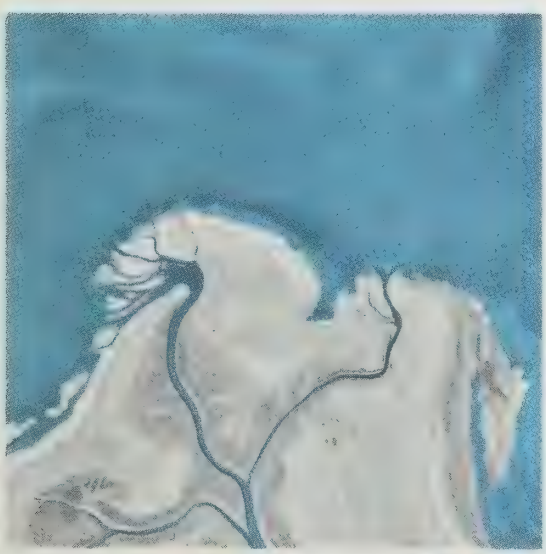
GROWTH OF A DELTA

These photographs of the Birch River Delta, taken at intervals of ten and fifteen years, demonstrate the gradual build-up of river-borne silts at the mouth of the river as it enters Lake Claire. As the accretion of silts slowly emerges above the water level, many small channels and perched basins are formed and new vegetation quickly becomes established along their edges.

BIRCH DELTA,
1945



BIRCH DELTA,
1955



BIRCH DELTA,
1970

the Athabasca River Delta is still encroaching into Lake Athabasca, and the Birch River Delta is expanding into Lake Claire. Because of its low rate of sedimentation, the Peace Delta is now considered inactive, compared with the still active Athabasca and Birch Deltas. As the Athabasca Delta grows and matures, filling the west end of Lake Athabasca, it is quite likely that the Athabasca River will eventually flow directly into the Slave River.

The Climate

Winters in this northerly Peace-Athabasca Delta region are long and cold, and summers are short and cool. The large bodies of water in the area, however, do have a moderating influence, extending the frost-free period and growing season to about 100 days—20 days longer than in the surrounding uplands. The average annual precipitation is 13 inches, while the average calculated loss from evaporation is 16.5 inches, resulting in a water-balance deficit of some 3.5 inches each year. From late October until mid-April, snow covers the ground to an average maximum depth of 20 inches, while ice covers lakes, ponds and rivers to a depth of as much as five feet.

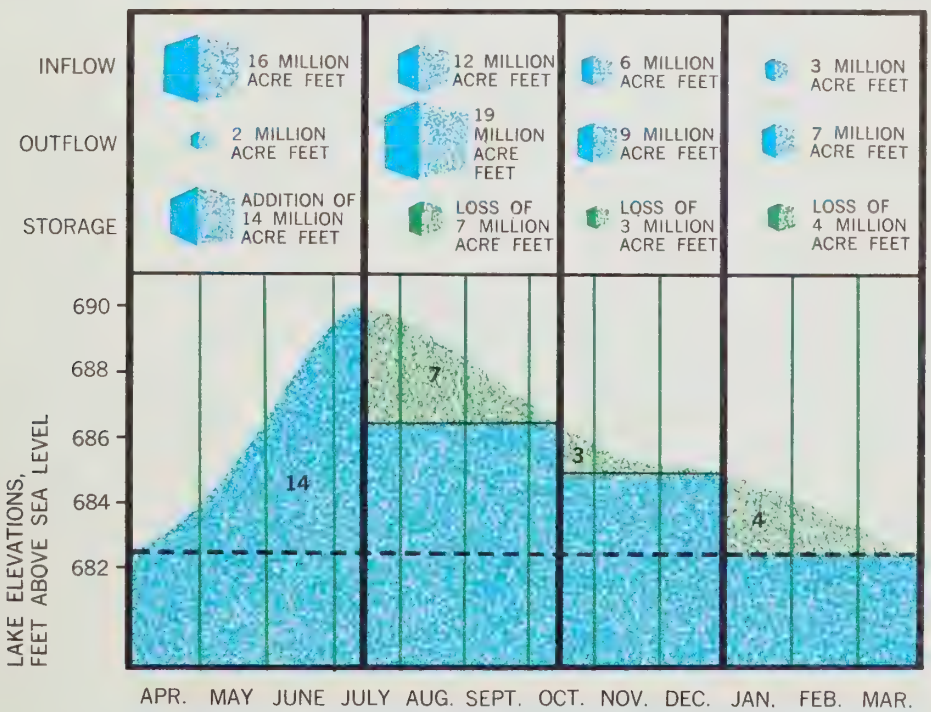


THE VITAL WATER SYSTEM OF THE DELTA

Life in the Peace-Athabasca Delta evolves from a hydrological pattern frequently climaxed by the flooding of the Delta in June or July, when all of the channels, lakes and perched basins are filled by flood waters from Lake Athabasca. By late summer, as water drains out of the Lake, levels of Lake Athabasca and the Delta lakes begin to recede, continuing until minimum levels are reached in March and the Delta waits to be recharged once more with spring and summer runoff.

From April to mid-July the water level of Lake Athabasca rises about seven feet, approaching 690 feet above sea level. As this rise in level draws near its peak, water stored in the Lake flows into the channels and lakes of the Delta, spilling into the surrounding depressions and perched basins.

This phenomenon of flooding in the Delta has been created by a combination of inflow from spring runoff into the Lake and a limiting of outflow caused by a coinciding high water level in the Peace River. The volumes of water involved in this curious occurrence are illustrated below.



Diagrammatic study of typical water balance in Lake Athabasca, showing seasonal input, outflow and changes in volumes of water stored in the lake, resulting in altered lake levels.



Inflow from the 110,000-square-mile watershed of the Athabasca and Fond du Lac Rivers averages approximately 36.5 million acre-feet per year, with 16-million acre-feet entering during the 3½ month period, April through mid-July. Obviously the supply of water at this time is more than sufficient to raise the level of Lake Athabasca very significantly, unless there occurs a correspondingly large and rapid outflow through its drainage channels.

It is in the natural control of outflow from Lake Athabasca that the unique aspect of the Lake's water balance comes into play. Lake Athabasca is drained through two channels, the Rivière



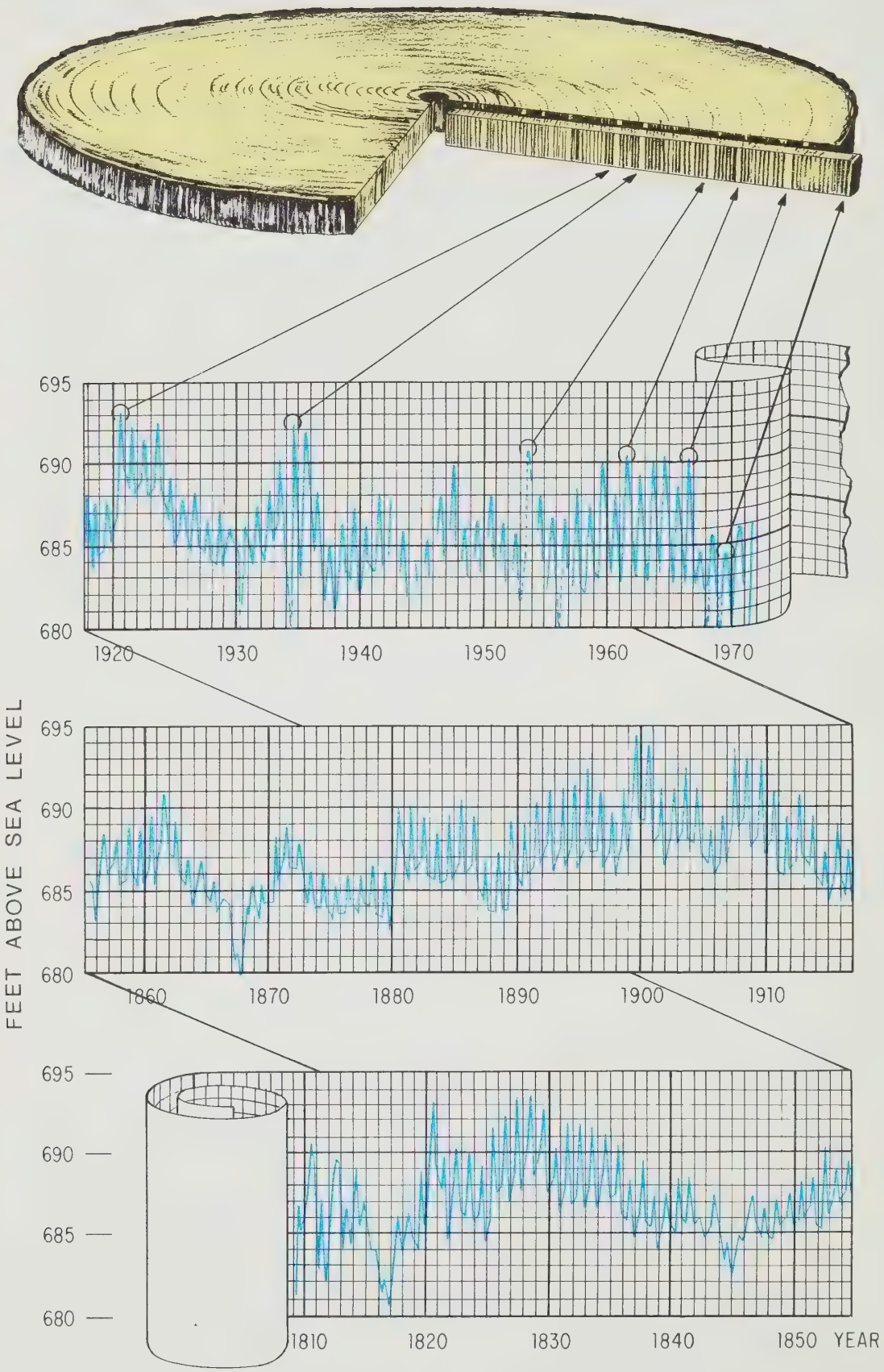
LOW LEVELS ON THE PEACE RIVER

When the level of the Peace River falls below the level of Lake Athabasca, waters of Lake Athabasca flow unimpeded northward into the Slave River, while waters of the delta flow back into Lake Athabasca through the Mamawi - Lake Claire system, draining the streams and small lakes and ponds of the delta.

des Rochers and the Chenal des Quatre Fourches, both of which join the Peace River. The Rochers carries 90 percent of the outflow. The volume of water draining out of the Lake is in proportion to the level of the water in Lake Athabasca and to the level of the water in the Peace River. As shown in the accompanying illustrations, *the water normally flows north in these channels toward the Peace River, but reverses its direction of flow when the water level in the Peace rises higher than the level of Lake Athabasca. During most spring floods, the water level on the Peace River has risen sufficiently to retard or reverse the flow out of Lake Athabasca, resulting in a back-up or storage of water in the Lake which, in turn, spills out to flood the Delta.*

If spring flood waters are held in the Lake, the Delta will be inundated. If these waters are permitted to flow rapidly out of the Lake, very little flooding occurs on the Delta.

WATER LEVELS OF LAKE ATHABASCA, 1810 TO 1970, ESTIMATED FROM TREE-RING DATA.



LAKE ATHABASCA WATER LEVELS

Water levels in Lake Athabasca have been measured and recorded only since 1930, a relatively short period upon which to base a study of annual fluctuations and to assess their effects on the biological development of the Delta. Additional data were necessary. These were provided by an examination of the growth rings of older trees inhabiting the levees of the major Delta rivers. Annual tree growth may be measured by the width of the annual rings of the tree trunk. Since the growth of these trees is related to soil moisture, which is determined by river and lake levels, it was possible to estimate lake levels for a period extending back to 1810. The accompanying diagram strikingly illustrates this relationship. It is evident that water levels in Lake Athabasca and in the Delta have fluctuated widely over the past 160 years.

This record indicates that the long-term average mid-July level, which dictates the pattern of plant life in the Delta, has been about 689 feet above sea level. The maximum for mid-July has been five feet higher than this average level, while the minimum for this period appears to have been some seven feet lower.

Equally important is the rise in water levels from the late-winter minimums to the high summer peaks. Unfortunately, a long historical record of winter levels cannot be reconstructed. Estimated water levels for late May, however, show that between May and July, water levels have usually increased by almost three feet over May levels. Because the Delta is extremely flat, this further rise above May levels has caused the extensive flooding which is the very lifeblood of the Delta ecosystem.

Effects of Water Levels on the Delta

The key to the Delta's unique character, then, has been the recurrent summer flooding, followed by a recession of waters in the fall and winter. This fluctuation in water levels has fostered an environment in which plant and animal life have achieved a balance that is dependent on frequent flooding. The record does indicate that there have been times of drastic variation from average conditions. But it is evident that this, too, has been an integral feature of the environment and both the extreme highs and lows have had their influence on the development of the Delta.

During the summer flooding, both the Delta's groundwater system and the numerous ponds and marshes are recharged. In the late summer and fall groundwater begins to recede. Since the relatively impermeable silty clays of the Delta severely limit the lateral movement of water from the major lakes and streams into the surrounding subsoils, flooding is essential to maintain groundwater levels and perched basins.

Varying amounts of dissolved salts are carried by the waters flowing into the Delta from the Athabasca and Birch Rivers. Evaporation in low-water years increases the concentrations of these salts — chlorides and sulphates of sodium, calcium and magnesium — which accumulate in the Delta's lakes. Frequent flushing by flooding of the Delta carries away this accumulation and preserves the chemical balance of the Delta waters.

ECOLOGICAL SUCCESSION

Parallel to the evolution of a delta's landscape, the plant and animal life develop as part of a complex ecosystem. The fundamental biological development commences with the establishment of vegetation. Five categories of plant communities — aquatic, shore, meadow, shrub and forest — exist in a continual state of transformation. Those that are adapted to the aquatic and nutrient-rich marshy edges will be replaced gradually, as the young site matures, by plants adapted to drier, more nutrient-poor conditions. This almost imperceptible but perpetual conversion from aquatic to meadow and wooded communities is mirrored in the changes that occur in animal populations. The continual transformation of plant and animal communities is referred to as ecological succession.

The process of plant succession from seedling growth on mud to mature forest takes place over the course of decades, or even centuries. Interrupting this relatively slow process of plant succession are other, much faster-paced natural occurrences, such as droughts, floods and fires, all of which produce abrupt and rapid adjustments in the vegetation pattern, in the wildlife habitat and in the abundance of some wildlife species.

Historically, the key factor in the Peace-Athabasca Delta's diversity of plant communities has been the recurrent flooding

pattern. It has been this almost annual flooding that has prevented meadow communities from undergoing gradual succession to willow or forest. If flooding does not occur for several years, water levels on the Delta decline and the process of plant succession commences along the exposed edges of marshes and lakes.

Succession proceeds most rapidly in its early stages. Sedges and grasses or young willow communities can become well established on exposed mud in as short a time as three summers. The later stages of succession, on the other hand, progress more slowly. It might take 10 to 15 years for well-established grasslands to be replaced by a willow community, and it could take as long as 25 years for the willows to be replaced by a deciduous forest community.

But if these Delta plant communities are flooded, the process of plant succession will be interrupted, and, if the flooding is of sufficient duration, it may even be reversed. Willows may be killed by prolonged flooding of several feet in depth. Certain grasses cannot tolerate flooding through the entire growing season and will gradually die out. Bulrushes, cattail and several other emergents, however, thrive in water one to three feet deep and can do well under prolonged inundation.

WILDLIFE HABITAT

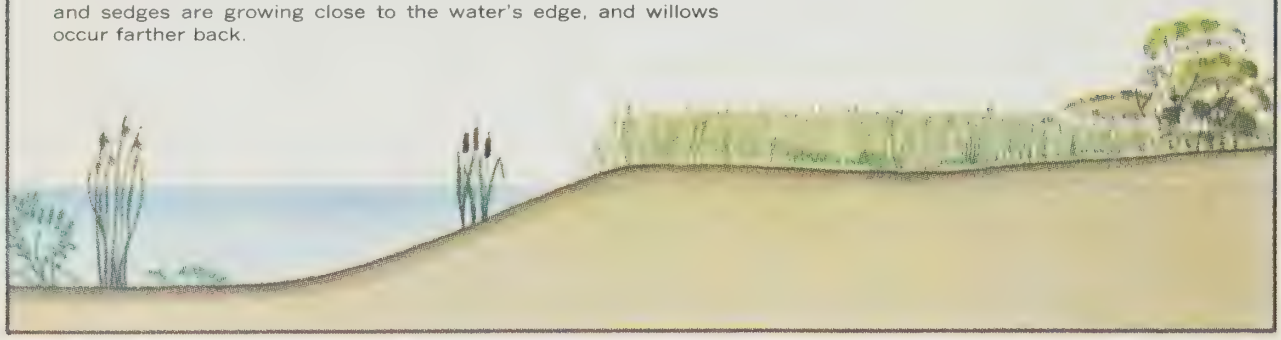
The Delta is inhabited by wildlife and fish that find suitable habitat here in which to sustain life. Each species has its own particular requirements and it is the rich diversity of plant and aquatic communities of the Delta that has produced a place to live for nearly 215 species of birds, 45 kinds of mammals and 20 species of fish.

The extent of each habitat at any given time limits the numbers of each wildlife species which the Delta can support. The populations of some animals and fish are determined by the total acreages of appropriate habitat available to them, while those of waterfowl are governed mainly by the length of shoreline providing suitable habitat types.

During the study, major habitat types were delineated, mapped and measured, providing a base for estimating wildlife populations and the carrying capacity of the Delta.

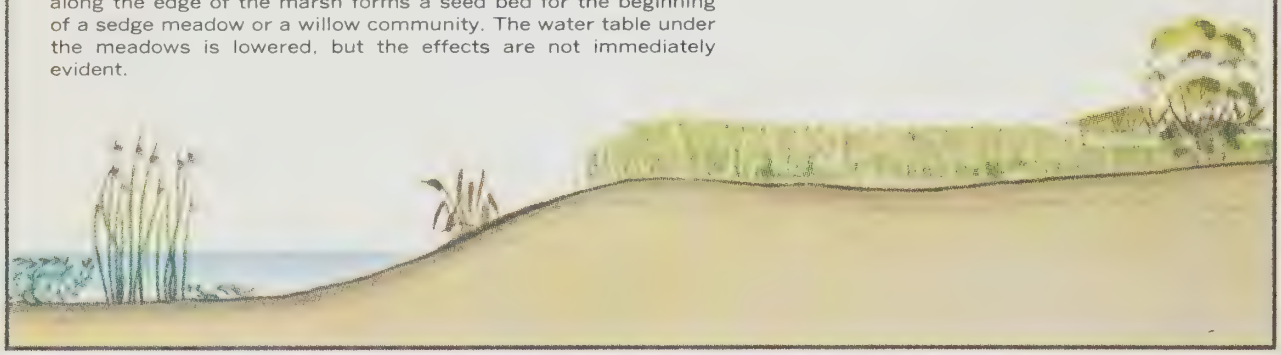
Year 1 Average Water Level

Plants on the Delta respond quickly to changes in water levels. In this illustration bulrushes are "holding their own" in the deeper water, while cattails are thriving along the marsh edge. Grasses and sedges are growing close to the water's edge, and willows occur farther back.



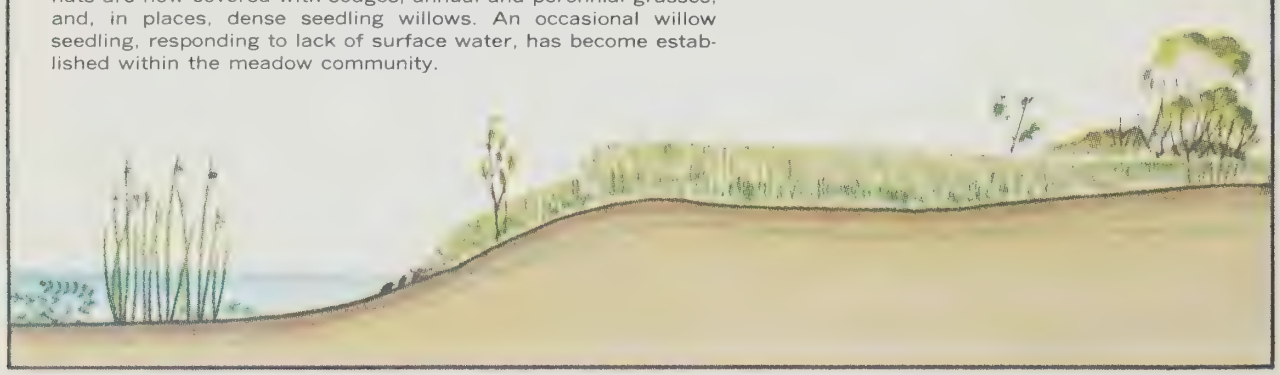
Year 2 Lowered Water Level - First Year

Bulrushes begin to increase in shallower water, while cattails start to die out when out of the water. The exposed mud flat along the edge of the marsh forms a seed bed for the beginning of a sedge meadow or a willow community. The water table under the meadows is lowered, but the effects are not immediately evident.



Year 3 Lowered Water Level - Second Year

The bulrushes in water continue to increase. The former mud flats are now covered with sedges, annual and perennial grasses, and, in places, dense seedling willows. An occasional willow seedling, responding to lack of surface water, has become established within the meadow community.



PROCESS OF SUCCESSION

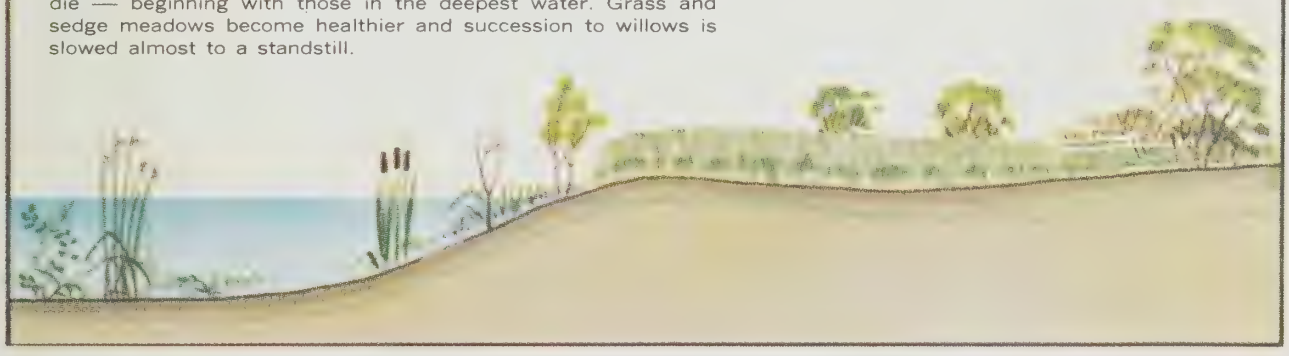
Year 4 Lowered Water Level - Third Year

The succession process continues. Cattails have become established along the shallow water edges of the marsh.



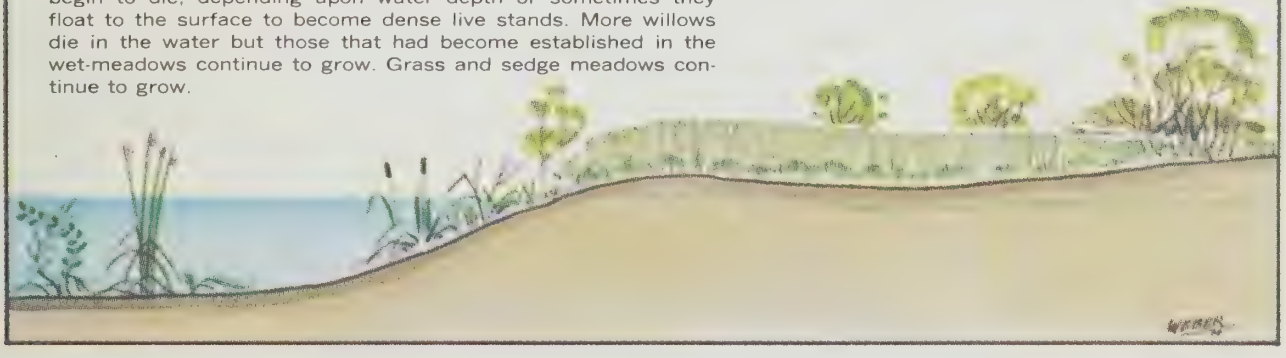
Year 5-6 Water is Raised to Former (Average) Level

Bulrushes thrive for a year or two and then begin to decrease in vigor. The willows that encroached on the mud flats start to die — beginning with those in the deepest water. Grass and sedge meadows become healthier and succession to willows is slowed almost to a standstill.



Year 7-8 Water Held at Former Level

Bulrushes are not as dense as they were when water levels were lower. They can withstand many years of flooding. Cattails may begin to die, depending upon water depth or sometimes they float to the surface to become dense live stands. More willows die in the water but those that had become established in the wet-meadows continue to grow. Grass and sedge meadows continue to grow.



Habitat Types on the Delta in Fall, 1970

	Acres	Miles of Shoreline
1. Open Water	416,000	
2. Emergents	50,000	
3. Mud Flats	54,000	1,450
4. Immature Fen	70,000	1,780
5. Meadow	297,000	3,350
6. Low Shrubs	315,000	2,770
7. Tall Shrubs	166,000	1,480
8. Deciduous Forests	45,000	280
9. Coniferous Forests	62,000	450
10. Rock Outcrop	58,000	350
Total	1,533,000	11,910

One of the main reasons for the Delta's high wildlife productivity lies in the fact that early successional habitats support the largest numbers of wildlife. Very considerable acreages of those early successional habitats numbered 1 to 5 in the accompanying table occur on the Delta, since these are dependent upon surface water, and the flat character of the Delta permits vast areas to be either temporarily flooded or permanently inundated to a shallow depth.

During midsummer floods, when the meadows are temporarily inundated, numerous ponds and perched basins are filled, thus maintaining the aquatic communities and the large amounts of shoreline within hundreds of small marshes and basins surrounding the Delta lakes.

It is abundantly apparent that within the Peace-Athabasca Delta the supreme arbiter of all life is the level of water in relation to the landscape.

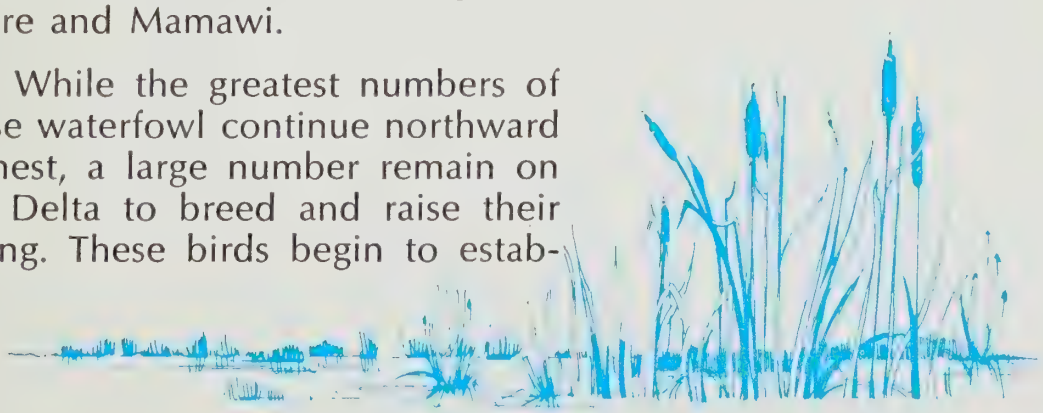


WATERFOWL

Each year, the Peace-Athabasca Delta harbors thousands upon thousands of migratory waterfowl. As a nesting and moulting ground, and as a giant staging area for spring and fall migrations, the Delta provides superb hospitality to fifteen species of ducks, four species of geese and the whistling swan.

In the spring its marshes teem with birds resting and feeding on their journey north to nest. Activity commences in late April with the arrival of the Canada geese, just as the first open water appears. During the first three weeks of May, 1971, counts indicated that some 400,000 ducks, numerous swans, and 145,000 geese stopped to rest and feed before proceeding to nesting grounds in the arctic or elsewhere on the Delta. These staging birds prefer the mud flat, immature meadow, emergent and meadow shorelines of the largest Delta lakes, particularly Lakes Claire and Mamawi.

While the greatest numbers of these waterfowl continue northward to nest, a large number remain on the Delta to breed and raise their young. These birds begin to estab-



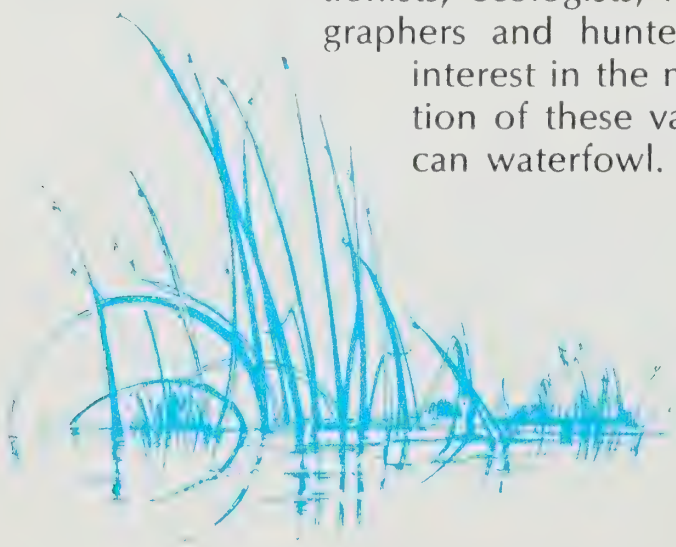
lish their breeding territories in early May, settling mainly along the shorelines of the perched basins which are ideally suited to their needs, although stream channels and marshes may also become breeding grounds. It was estimated that 163,000 breeding pairs of ducks produced approximately 600,000 young on the Delta in 1971.

During periods of drought on the prairies, the Delta has also nurtured huge populations of waterfowl that have ventured further north in search of breeding grounds.

By mid-summer, ducks and geese that have bred elsewhere join the Delta's resident waterfowl for moulting. Here they find sufficient emergent vegetation and protected open waters where they may safely lose their flight feathers and wait for new ones to grow. In 1971, it was estimated that the population of moulting birds on the Delta reached 500,000.

By late August, many of the ducks that have lived on the Delta during the summer begin their southward migration. Others remain, awaiting the arrival of birds that have gone on to nest in the arctic after visiting the Delta in the spring. Now, in the fall, the arctic birds gather on the Delta to rest and feed before commencing the next stage of their southward migration. As waterfowl of four major flyways converged on the Delta in the autumn of 1971, approximately 1,200,000 ducks and 165,000 geese and swans stopped to feed on the mud flats, immature meadow and emergent shorelines of the Delta's large lakes.

Waterfowl on the Delta are not only an important source of food to the people of Fort Chipewyan, but these birds are also a valued resource throughout this continent as they follow four flyways to many points in Canada, the United States, Mexico and some parts of Central and South America. Conservationists, ecologists, naturalists, wildlife photographers and hunters all have a continuing interest in the management and preservation of these vast flocks of North American waterfowl.



MUSKRAT

A semi-aquatic mammal, the muskrat has been the traditional mainstay of Delta trappers, valuable as food as well as for pelts. Muskrats live in marshes, where they construct houses of emergent vegetation, or in dens dug out of mud banks.

Muskrat populations on the Delta have fluctuated greatly in the past, depending upon water levels in the marshes, and perhaps in part, upon a little understood ten-year population cycle. They survive the winter best in marshes having several feet of water and an abundance of both emergent and submergent aquatic plants. The more productive marshes are those refilled during floods. If floods are absent for several years these marshes gradually become too shallow to support muskrat over winter. These animals do not survive well on the larger interconnected lakes, for winter water levels on these lakes decline in a similar manner to Lake Athabasca levels.

Prior to this study, little quantitative information had been recorded on Delta muskrat populations. An indication of the size of historical populations can be estimated from records of pelts harvested within the Wood Buffalo Park portion of the Delta, where about 60 percent of the suitable muskrat habitat is found. The Park catch reached a peak of 144,000 pelts in the winter of 1965-1966. In 1960-1961, 91,000 were harvested. However, in 1962 only 32,000 were taken. Similar ups and downs in the catch have undoubtedly occurred in the Chipewyan Indian Reserve, and in the Alberta portion of the Delta,



containing about 40 percent of the muskrat habitat. Although exact data are not available, it is likely that muskrat numbers on the entire Delta during the mid-1960's exceeded 200,000 prior to the spring trapping season, and the fall populations in some years could easily have been 250,000 to 300,000, or greater.

BISON

Wood Buffalo National Park supports the largest free-roaming herd of bison in North America. Descendents of the wood buffalo and the plains buffalo, the Park's present herd numbers about 14,000 bison. Almost 10,000 of these animals now inhabit the Delta portion of the Park, ranging over vast grasslands surrounding Lakes Claire and Mamawi — habitat somewhat resembling the pristine North American tall- and short-grass prairies where their progenitors roamed.

These meadows on the Delta are of two types: grass meadows, dominated by a tall, coarse wet-meadow grass *(Calamagrostis canadensis),* and sedge meadows dominated by a sedge species *(Carex atherodes),* which, although it looks like a grass, is not. The bison, if given a choice, prefer to eat the sedge in winter, and both sedges and grasses during summer. Both meadow communities require frequent flooding during part of the growing season, and it has been the recurring inundations that have nurtured this meadow growth and prevented the emergence of willow communities.

The size of the bison population is slowly increasing. The annual calf crop is now approximately 20 to 25 percent of the



herd, but winter calf mortality reduces this number to about 10 to 15 percent. Diseases account for some deaths, and a number of animals drown as they attempt to cross rotten ice at breakup. The timber wolf is the only significant natural predator, and packs as large as 24 wolves have been observed following the bison herds. Black bears may take an occasional calf and are frequently seen near bison, or feeding on carcasses.

Water levels on the Delta do not greatly affect survival of the animals themselves, but the maintenance of their grazing habitat is closely linked with the level of water.

MOOSE

Moose inhabit the older, higher, forested areas of the Peace-Athabasca Delta. Historically, and even today, they are important to the residents of the Fort Chipewyan area as a food source. Hides also provide material for clothing and handicrafts.

The diet of moose in summer consists of a variety of submerged aquatic plants; in winter they browse on the twigs of shrubs and young trees, mainly red osier dogwood and low willows. Moose prefer areas that support a mixture of habitat types, including marshes, low shrubs, and tall willows or conifers.



There are about 800 moose on the Delta, averaging one per square mile of

suitable habitat, and located mainly in the older parts of the Delta. The annual increase in the population is estimated at 20 percent, or about 160 animals, while the annual hunter harvest is estimated at 150 to 200 animals. It is evident that, at these rates of exploitation, the population cannot be expected to increase and will continue to remain well below that which the habitat will support.

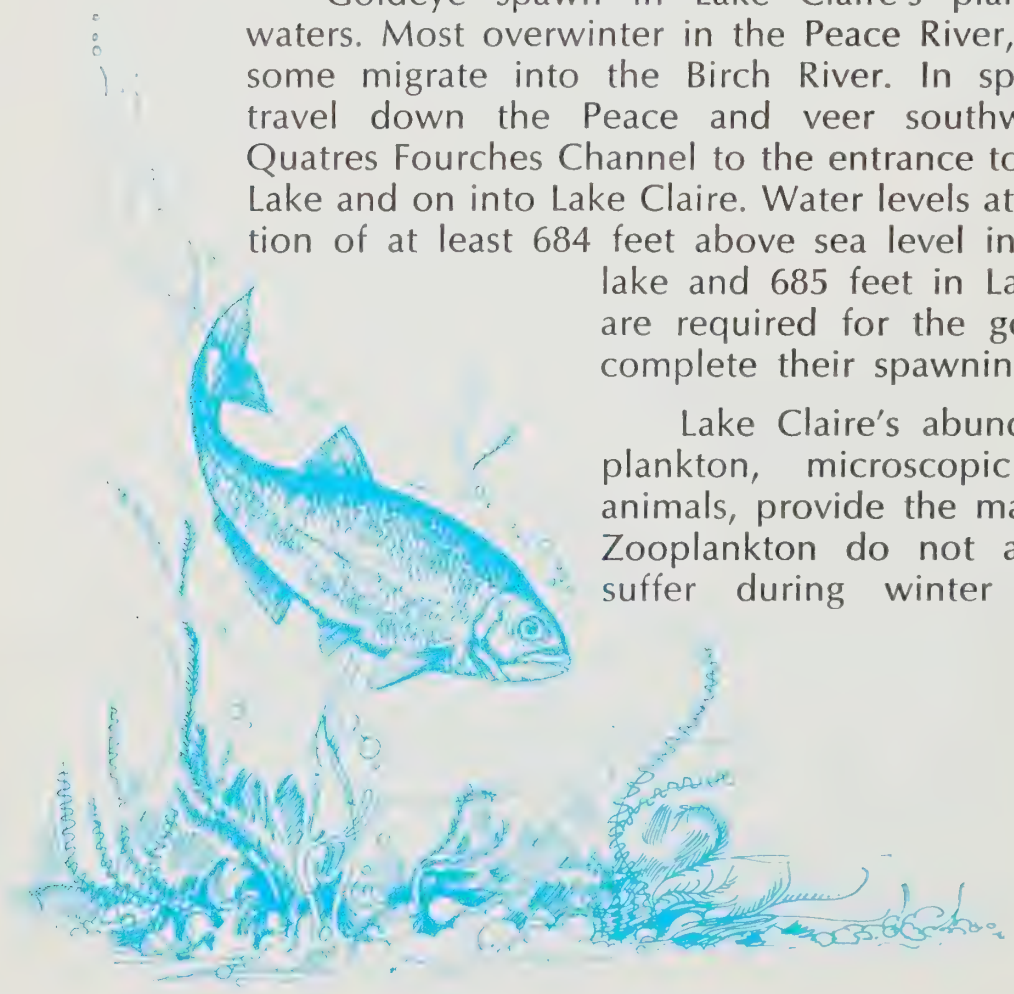
FISH

Relatively little attention has been given, in the past, to the fishery resources of Lake Athabasca and the Delta. Previous studies have provided only limited information on the productivity of the lake and its fishery potential. An analysis of all available information identified several fish species of economic importance in the Delta.

Goldeye

For a number of years, goldeye were commercially fished on Lake Claire. The catch having shown fairly consistent decline, the season was closed eventually in 1966.

Goldeye spawn in Lake Claire's plankton-rich waters. Most overwinter in the Peace River, although some migrate into the Birch River. In spring they travel down the Peace and veer southward into Quatres Fourches Channel to the entrance to Mamawi Lake and on into Lake Claire. Water levels at an elevation of at least 684 feet above sea level in Mamawi lake and 685 feet in Lake Claire are required for the goldeye to complete their spawning run.



Lake Claire's abundant zooplankton, microscopic aquatic animals, provide the major food. Zooplankton do not appear to suffer during winter in Lake

Claire, even though there may be less than a foot of water under five feet of ice in the lake. These aquatic organisms appear to overwinter successfully in a resistant stage and can withstand the rigors of freezing and low oxygen conditions.

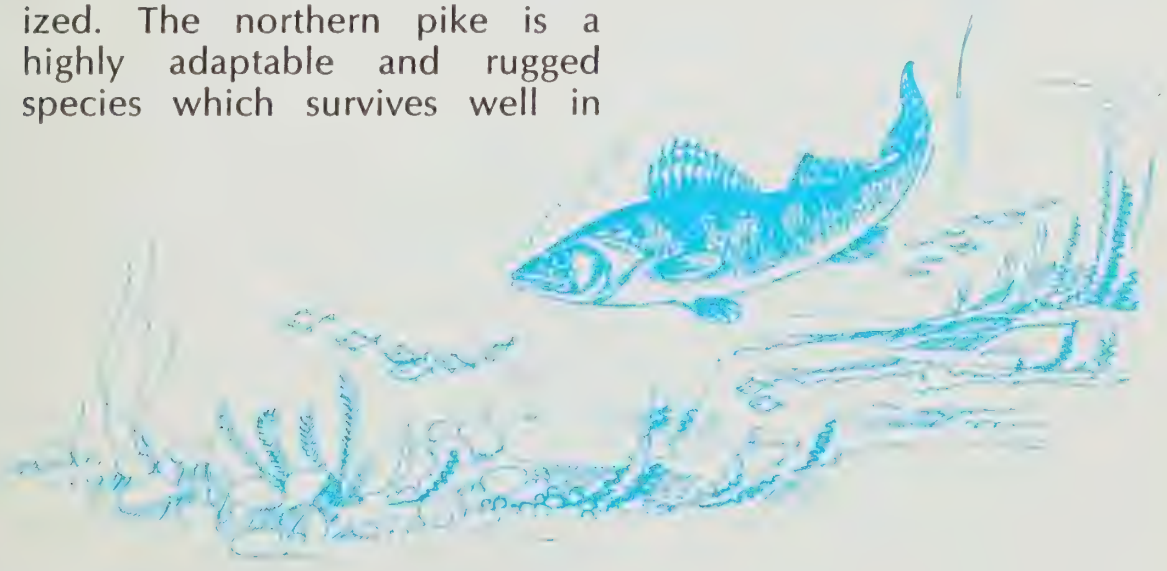
Adult goldeye begin retracing their route toward the Peace River in July, and the young begin to move out in late summer, continuing their migration until freeze-up.

Walleye

Richardson Lake is one of the major spawning areas for the commercially important walleye. Adult fish tagged here have been caught by fishermen in both the Alberta and Saskatchewan portions of Lake Athabasca. In March, the walleye leave Lake Athabasca and migrate up Big Point Channel toward Jackfish Creek on their annual spawning run to Richardson Lake. Historically, the backwater effects of Lake Athabasca maintained the levels of Richardson Lake well into the winter, and this permitted a flow from Richardson Lake into Jackfish Creek, before spring breakup, to attract walleye during their spawning run. If the water level of Richardson Lake is too low, however, the lake freezes to the bottom, and walleye must then wait until breakup to enter and spawn, or spawn elsewhere.

Northern Pike

The fertile marshes and rivers of the Peace-Athabasca Delta allow its northern pike to grow to trophy size, although they are not actively sought by anglers in this remote area, because of the muddy Delta waters. They are taken commercially on Lake Athabasca, but compared with other commercial species, have been relatively under utilized. The northern pike is a highly adaptable and rugged species which survives well in



shallow marshes of the Delta under a variety of water-level conditions.

Lake Trout

Lake trout do not live in the waters of the Delta, but are distributed throughout the deep waters of Lake Athabasca, especially in the Saskatchewan portion. They spawn in September in rock crevices just below the surface of the water. The eggs do not hatch until spring. Historically, the levels of Lake Athabasca have declined an average of four feet over winter. In years of extreme declines it is likely that egg survival was reduced because of exposure or freezing. Water fluctuations at other times of the year probably do not affect the lake trout to any great extent.





the region and its people


Discovery
Gordon L.
Thompson Landing
Artillery L.
Rae
Yellowknife
McLeod B.
Reliance
R.
Christie B.
Snowdrift
Snowdrift River
Caribou Is.
513
GREAT SLAVE LAKE
Fort Resolution
Rocher River
Tatison River
NORTHWEST TERRITORIES
Dawson Landing
Pine Point
Little Buffalo R.
SLAVE River
Thoa R.
Abitau R.
WOOD
Fort Smith
Fitzgerald
BUFFALO
Buffalo River
Camsell Portage
Uranium City
Eldorado
Otherside River
Gunnar
Fond-du-Lac
NATIONAL
PARK
Lake Claire
Fort Chipewyan
LAKE ATHABASCA
Otherside River
STUDY REGION
William R.
Vermilion Chutes
Birch River
Embarras Portage
DETAILED STUDY AREA
Old Fort R.
Richardson R.
ALBERTA
SASKATCHEWAN
Mikkwa R.
MOUNTAINS
RIVER
Cree Lake
Wabasca R.
BIRCH
Bitumount
Fort MacKay
Loon R.
Fort McMurray
Waterways
ATHABASCA River
Lenarthur
Kinosis
Quigley
Pingle
Pelican Portage
Conklin
ALTA
Christina
Peter Pond Lake
1382
Buffalo Narrows
Churchill Lake

three

What of the people of the Lake Athabasca Region? Where do they live? How do they live? How have the changes taking place on the Delta affected them?

To this point, Lake Athabasca as an integral part of the Mackenzie River system and its influence on the ecology of the Delta, have been dealt with in some detail. However, there has been no attempt made to draw a clear picture of the region as a place where people live, raise families, build communities and interact with each other to weave a unique fabric of social and economic activities to which their lives are tied.

In general terms, a region may be described in the light of its geographic and demographic resources and its particular economic characteristics. In the Lake Athabasca Region, the Lake itself is the dominant factor in terms of transportation, resources, various water-based economic activities, and concentrations of population. But the human dimension that is the catalyst in a region's growth — life style, human values, community structure and leadership — cannot be expressed by a recital of raw statistics. Some knowledge of the elusive quality of the human aspect is essential to understanding of the problems of the region.

Some 5,000 people live in five communities in this Lake Athabasca region. Fort Chipewyan, a predominantly native community, dominates the west end of the Lake, while in the Saskatchewan end of the Lake, the native communities of Camsell Portage, Fond du Lac and Stony Rapids/Black Lake are somewhat overshadowed by the vigorous mining community of Uranium City.

Industries of the region, transportation, communication, the culture and lifestyle of its people are naturally all based on the particular characteristics of the area. As in any region, its growth or decline depends on its economic development and the government programs for the area. The number of jobs available and the level of income in the region depend on its rate of growth.





Chipewyan, Cree, Metis and white residents form the community mosaic of Fort Chipewyan.

Through the first half of the twentieth century, the people continued to find their livelihoods in the resources of the land — trapping, fishing and hunting — to provide the necessities of life. Gradually, opportunities for employment in barging, lumbering, commercial fishing and government became available. Mining and oil exploration and development, however, bypassed the area, with the notable exception of the exploitation of the uranium deposits at Uranium City.

The continuing development of the Athabasca Tar Sands at Fort McMurray now promises the establishment of a very substantial industrial complex immediately to the south of the Lake Athabasca Region. Opportunities there could be very rewarding, especially for the people of Fort Chipewyan. However, past lessons indicate that the people of the region must make considerable progress before they are able to relocate successfully without suffering the debilitating social effects which so often accompany a move from the comparatively simple environment to the more complex urban scene.

By the 1960s, the process of population concentration, firmly established in southern Canada following World War II, had also become a centralizing force in this region. Virtually all families who once lived around the west arm of Lake Athabasca have now relocated in Fort Chipewyan. The 1972 population of the town has reached some 1,500 including 700 Cree, 235 Chipewyan, and 450 Metis.

FORT CHIPEWYAN, THE DELTA COMMUNITY

Because of its geographical proximity to the Delta, its traditional significance as a transportation hub, as a source of manpower and trading centre, and because of its present stage of urban-type development, Fort Chipewyan became the focus of attention in the study of communities in the region. Although this hamlet is unique in its relationship with the Delta and in the degree of its traditional dependence on trapping and fishing there, many of the conclusions drawn apply equally to the other regional communities of Stony Rapids, Fond du Lac and Camsell Portage.

At one time the people spent the winter months in the town and scattered to their ancestral homes for the rest of the year. Now the trend to an urban lifestyle, compulsory school-



P.A.D.P. PHOTO

The future of Fort Chipewyan.

ing, housing, social assistance and the medical facilities of the town have brought the people together on a permanent basis in Fort Chipewyan. Here they are able to enjoy such social and economic amenities as entertainment, stores, transportation facilities and permanent proximity to friends and relatives.

Perhaps the most important factor in this shift of population is the fact that trapping, fishing and subsistence hunting have ceased to be the predominant means of making a living. Muskrat has traditionally been the dominant cash crop, but the low waters of recent years and poor prices have combined to reduce trapping incomes. Now, with the virtually permanent establishment of home and family in the town of Fort Chipewyan, many trappers find the long days or weeks on the trapline a rather unattractive prospect. Gradually increasing opportunities for government or government-related employment have further reduced the importance of this occupation.

Complex forces, generated by increased communication, economics, technology and government policies, are changing the traditional lifestyles of the people of the region and of Fort Chipewyan. There is a major shift in the interests of the young

people away from the life led by their forefathers. Since most young people attend school during the winter months until they reach the age of 15, they have little opportunity to learn or practise the trapping skills of their parents. Their interest in fishing and hunting is attuned more to recreational pleasure than to the old-time serious business of providing food for their families.

To the old Indian trapper, who still finds the rewards of dignity of accomplishment and of stature in the community in the running of a successful trapline, the fact that his earnings are far below the national average is not of immediate concern. Nature is his environment; the trapline is his life. The loss of opportunity to trap, fish and hunt would mean, to him, the loss of his purpose as a human being; the loss of his life.

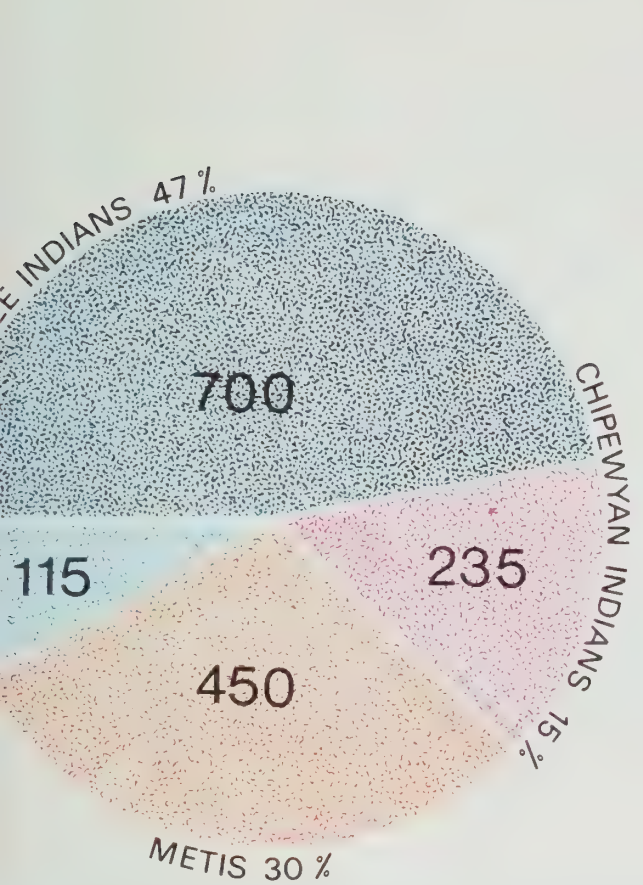
For the younger people, it is a different story. Earlier exposed to the values of the urban life and the consumer world, they are often frustrated by the restrictions of insufficient income, lack of mobility and lack of opportunity in this remote area. Many are plainly dissatisfied with the environment in which they find themselves and the mode of life imposed upon them. Having learned of other ways of life, they have difficulty in accepting the simplistic values of their forefathers.

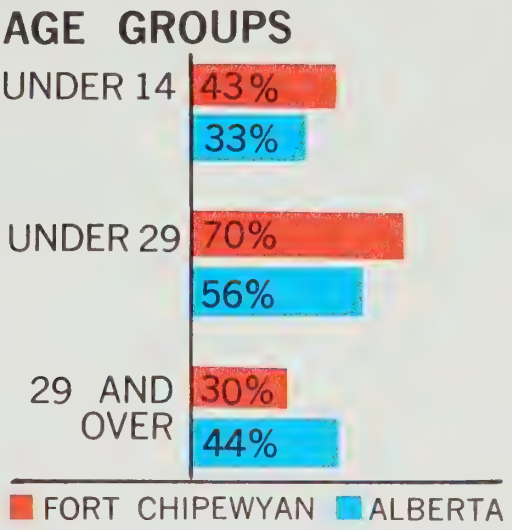
Vital statistics of the town point to an ever-increasing labor force of people who will desire more than the bare necessities from life.

- Families are above the national average in size.
- 70% of the population is under 29 years of age, more than half of which is under 14.
- Family heads are younger than ever before.
- Very little outward migration is taking place.
- Infant mortality is decreasing.
- Life expectancy is increasing.
- The present population level of 1,500 can be expected to exceed 2,000 by 1980.

Economic trends in the Fort Chipewyan segment of the region are not encouraging. Since 1965 the estimated income from trapping, forestry, barging and fishing has shown a substantial decline, only partially offset by modest growth in gov-

THE PEOPLE OF THE PEACE-ATHABASCA DELTA







ernment employment and local businesses. During 1971 and 1972, wage employment with the Peace-Athabasca Delta Project and above-average income from fire-fighting helped to counteract the general economic decline. But the overall downward trend is a matter of real concern, particularly in view of the projected population growth and consequent expansion of the labor force.

TRENDS IN FUR PRODUCTION

The number of trappers, trapping days per man, and the number of muskrat pelts traded at Fort Chipewyan have decreased markedly in recent years. Between 1960 and 1968 the average annual harvest in the Park portion of the Delta was 65,000 pelts. During 1968 to 1972 the Park catch declined drastically from 38,000 to less than 2,000 muskrats. Data are incomplete for the entire Delta harvest. Estimates range from 70,000 to 90,000 pelts in the early 1930's, and 40,000 to 50,000 during 1947-49. Mid-1960 catches must have been considerably

greater than the 65,000 pelts taken in the Park. But by 1971-72, the entire Delta harvest had declined to 18,500 pelts.

Reduced muskrat populations, low prices, urbanization and changes in social values which have led to loss of interest in trapping, have all contributed to this decline in fur production. Most of the present generation of trappers are now over 35 years of age. With few young people learning trapping skills, there will be a continuing decline in the number of men with the skills or the desire to take over when these trappers are ready to retire.

Although trapping, as a livelihood and industry, appears to be on the wane, some 60% of the hamlet's male labor force still trap at least in a casual fashion to supplement other incomes. Probably no more than a dozen men now realize an average annual income of $2,500 or more from muskrats. Yet, with planned management of the muskrat marshes and improved methods of marketing, trapping could provide a substantial income for Fort Chipewyan.

It is significant that the Chipewyan Band, as well as a number of other trappers, have requested that remedial works be undertaken on the Delta to improve water levels in the

L. ALLISON PHOTO





L. ALLISON PHOTO

muskrat marshes to ensure a reasonable population for harvesting. It seems likely that if the muskrat harvest were more dependable than in the past few years, and if marketing were better planned, many of the people would muster up new enthusiasm and make a greater effort on the traplines.

FISHING

Always an essential food resource for the people of this region, the fish of the Lake Athabasca waters — lake trout, walleye, goldeye, pike and whitefish — are all taken in quantity. Commercial fishing developed in the middle of this century. The Saskatchewan fishery, commenced in the 1920's, has generally been less affected by the vagaries of economic conditions and natural cycles than the Alberta fishery, established in 1943.

In Alberta, for example, the pike and whitefish are not of commercial quality, while the widely fluctuating goldeye catch declined so rapidly in the '60's that commercial fishing of that species was suspended in 1966. This decline was not attributed to low water levels.

The important Fort Chipewyan fishing grounds are on Lakes Athabasca, Richardson, Claire and Mamawi. Fish processing was

carried on at The Willows, located at the mouth of the Athabasca River, until recently, when the plant was moved to Crackingstone Point, Saskatchewan. This move has created difficulties in transporting Alberta spring catches to the Crackingstone Plant at a time when the east end of Lake Athabasca is still frozen. Changes in Alberta laws restricting non-resident fishermen, coupled with the transportation difficulties, have probably been the cause of the recent decline in value of the Fort Chipewyan fishery. The key to sustaining this marginal industry seems to be maintaining all phases of the fishery—harvesting, processing and marketing on a Lake Athabasca-wide basis.

A program to get more modern fishing fleets into operation and to establish more economic processing facilities has been undertaken by the Fort Chipewyan-based Athabasca Fishermen's Co-op, in conjunction with the Federal Department of Indian Affairs and Northern Development, the Freshwater Fish Marketing Board and the Governments of Alberta and Saskatchewan. Properly managed, this development could have substantial long-term, if seasonal, benefits for the Fort Chipewyan community, by increasing fishing employment from 30 to 60 men and providing an additional $40,000 of disposable income for the community.

RIVER NAVIGATION

In the past, the Athabasca-Slave River system served as a major waterway for barge freight to the Northwest Territories, offering good wage employment for many residents of Fort Chipewyan and the surrounding region. However, the opening up of truck traffic on the new Mackenzie Highway in the 1950s began cutting into the water-transport cargo, and the Pine Point railway, completed in 1965, soon reduced water transport via the Athabasca-Slave system to a trickle. By 1971, about 70% of all freight shipped downriver from Hay River was brought to this marine terminal by rail transport. While barges still service Fort Chipewyan, Uranium City, and regional lumbering projects, Fort Chipewyan is no longer very important as a local port.

OTHER REGIONAL RESOURCES

Forestry

The only marketable timber in the area is located almost entirely within Wood Buffalo National Park, along the levees of the Peace and Athabasca Rivers. Timber cutting began in Wood

Buffalo National Park in 1951, to supply the needs of Eldorado Mining and Smelting Limited in Uranium City, Saskatchewan. Employment from logging and sawmill operations netted Fort Chipewyan residents approximately $200,000 per annum during the period 1967 to 1969, but fell to half that amount in 1970, reflecting decreased demand. It is possible that in the next few years the National Parks Branch may terminate the practice of lumbering within the Park boundaries. While the close of lumbering might be in the long-term interest of Park values, the immediate impact will be a significant loss of jobs and income. Plans should be initiated now for new projects to provide work for people who will lose their livelihoods when this occurs.

Mineral Resources

The minerals in the Lake Athabasca region include gypsum, granite, gold and uranium. Mining activities began in the region in the 1930s, concentrating in the Saskatchewan portion, and creating the Towns of Black Bay, Beaverlodge, Goldfields, and Uranium City. Major operations continue in Uranium City and on the Athabasca Tar Sands near Fort McMurray, approximately 100 miles south of Lake Athabasca. Although mineral activity is not at present of any significance to Fort Chipewyan, some opportunities could arise out of the possible development of a building-stone quarry in the area.



Recreation and Tourism

Lake Athabasca itself does not have a high potential for water-based recreation in comparison with its surrounding lakeland. The water of the lake is generally too cold for swimming or water skiing and it is often subject to strong winds and high waves which are not conducive to pleasure boating.

There is a recognized potential, as yet undevel-

oped, for "non-consumptive" tourist recreation in the form of sightseeing and photographic tours of the Delta and the adjacent Wood Buffalo National Park. This will probably develop gradually as the biotic character and uniqueness of the Delta becomes known.

A viable recreation industry at the local level would require considerable managerial input which at the moment is lacking. Considerable planning and discussion with various local organizations would be necessary to expand the people's understanding of tourism and its potential. Only then would it be possible to exploit the opportunities which might be available over the next few years.

EMPLOYMENT, INCOMES AND ASSISTANCE

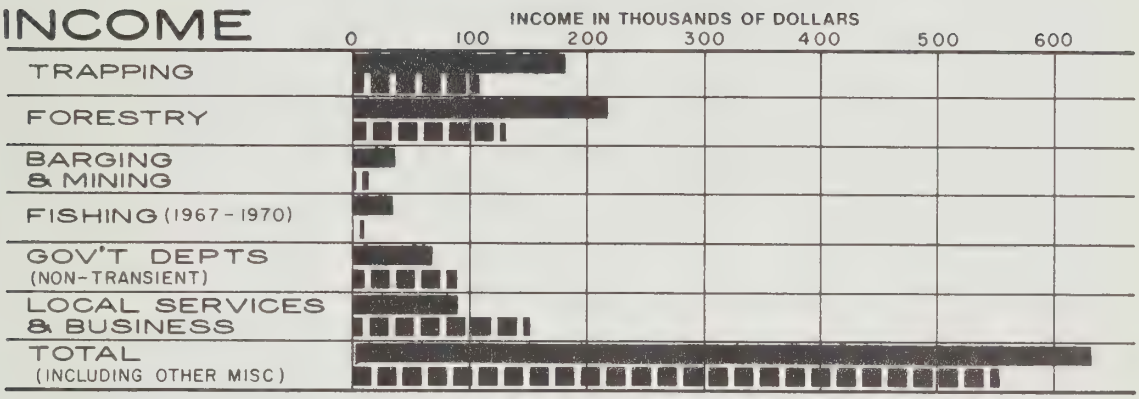
The major regional concerns about employment conditions have centred on Fort Chipewyan, because of its dependence on the Delta for trapping and fishing.

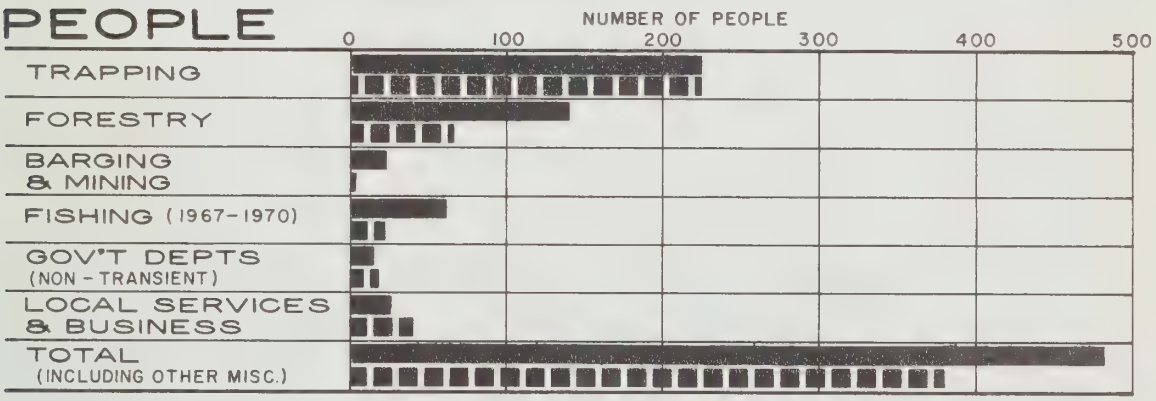
Since most employment in Fort Chipewyan is seasonal, it is most meaningful to speak in terms of the annual utilization rate for the labor force. It is estimated that in 1970 only 22 percent of the male labor force worked at jobs other than trapping during the year. If the time spent in trapping is included, it may be said that 29% had work. Few meaningful job opportunities exist for women. The steady growth in the labor force, combined with the disturbing downward trends in trapping, fishing and forestry, paints a very poor current and future employment picture.

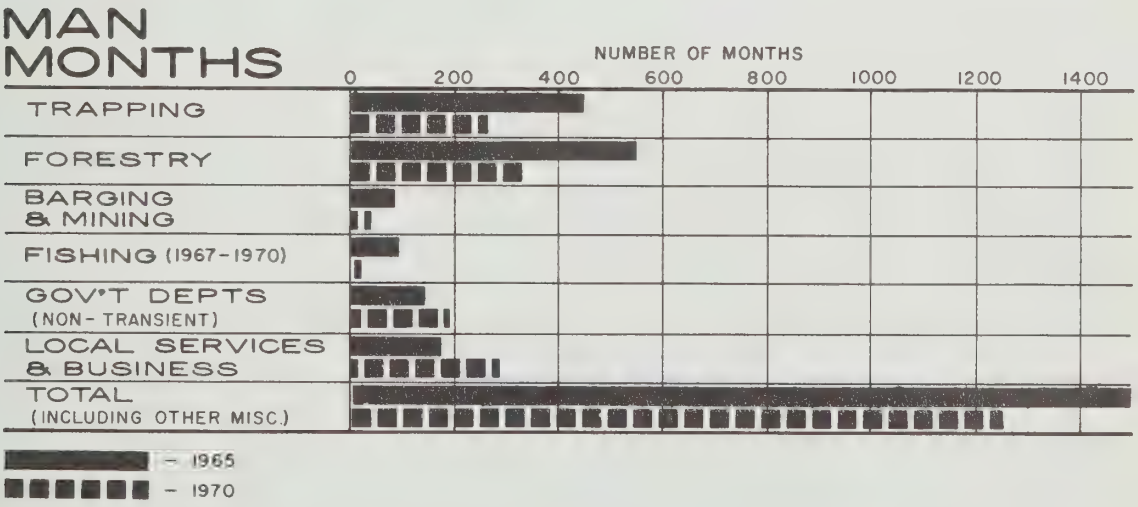
The seasonal aspect of local work further complicates the picture, since many of the jobs last for only short periods, and there are many months in which labor-force utilization is far below the indicated 20 to 30 percent. The lack of work means low incomes for the community. Sources of work and incomes are depicted on the following charts.

The low income and high unemployment situation has all the earmarks for poverty generation with high and continually rising welfare inputs.

The average per capita level of earned productive income in Fort Chipewyan dropped from an estimated $526 in 1965, to $380 in 1970. Considering that the Alberta per capita income level is in excess of $2,400, the area is clearly at the poverty level when compared to provincial standards. However, it should be stressed that within the Fort Chipewan community only a







MAJOR INCOME PRODUCING & EMPLOYMENT CATEGORIES FOR LOCAL PEOPLE IN FORT CHIPEWYAN AREA (1965-1970)

small number of the people would actually be considered deprived.

Social assistance, and various other transfer payments, from both provincial and federal sources, supplement the earned income almost dollar for dollar. Although difficult to document precisely, social assistance is obviously increasing, with a level of approximately one quarter of a million dollars anticipated for 1971-72. Assistance from the provincial government has increased some 300 percent over the last five years. Federal assistance for the Treaty Indians has increased approximately 80 percent during this period. The average number of persons receiving federal assistance has remained steady at about 540, and at this level about 55 percent of the Treaty Indians would be covered.

In addition to social assistance, various other transfer payments are of significance, including family allowances, old age pensions and unemployment insurance, which together are estimated to total approximately $362,000 annually.

Traditional lifestyles are rapidly disappearing on the Delta.



L. ALLISON PHOTO

THE UNEMPLOYMENT PROBLEM

In the face of downward economic trends and the prospect of ever-increasing population, the main goal of the people of Fort Chipewyan must be to provide more jobs. These jobs, to be meaningful, must cover the spectrum from traditional trapping and fishing to new projects which appeal to younger people willing to learn more contemporary skills. This will require a concerted effort on the part of the people and of governments and their agencies. At best, it will bring only a slowly growing improvement, barring unforeseen adverse economic developments.

The basis for these conclusions is in the assessment of the value of trapping and fishing, and therefore, of water levels, to the local economy of Fort Chipewyan. Existing and potential employment possibilities were identified and studied. The significant finding was that the full development of all known possibilities could increase the labor utilization rate to only 40 percent from it present 20 to 30 percent range.

Employment is therefore a critical problem in the community. The creation of a few jobs is considered as marked progress. Because of the lack of other job opportunities, trapping and fishing are still important locally at this point in time.

THE ROLE OF GOVERNMENT

The degree to which Fort Chipewyan, as a community, and its people, as individuals, achieve their true potential over the coming decade depends greatly on the policies and programs of governments. In order to meet the needs of the community, improvements will be required in the co-ordinative capability of various government departments, at the federal and provincial levels, and in the development of local personnel for the administration of programs. The same co-ordination will be necessary in determining the content of the programs themselves.

Certainly governments and their departments must view Fort Chipewyan in a more positive, long-term and generally enlightened manner. Overall economies, rather than those of a particular department, must be considered. Meaningful communication must be established and maintained with the com-

munity. Clearly, the process of local government must be upgraded in a way that will enable the diverse interests and groups within the community to cope as an entity with the outside world and, in particular, to work effectively with senior governments.

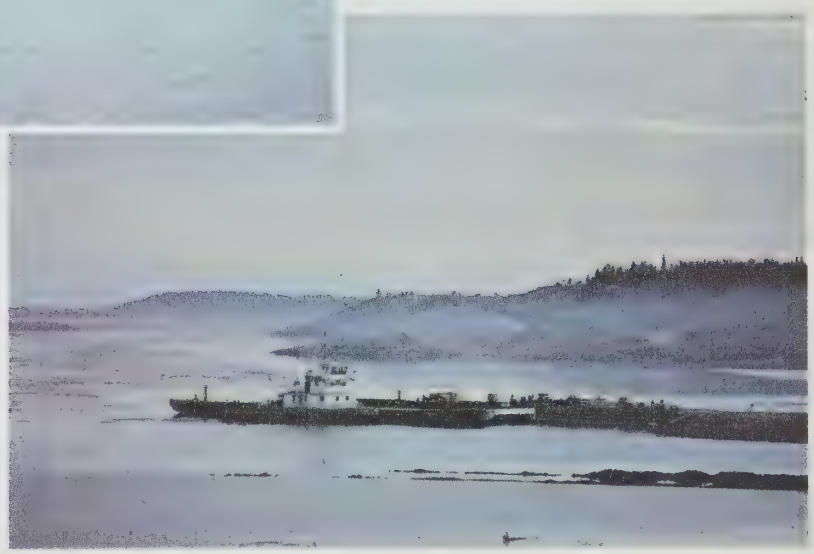




Fort Chipewyan, looking east.

Net fishing is the traditional method of fishing Delta lakes and channels.

Barge transport links the Delta with railhead at Fort McMurray.





a perspective on two regional assets

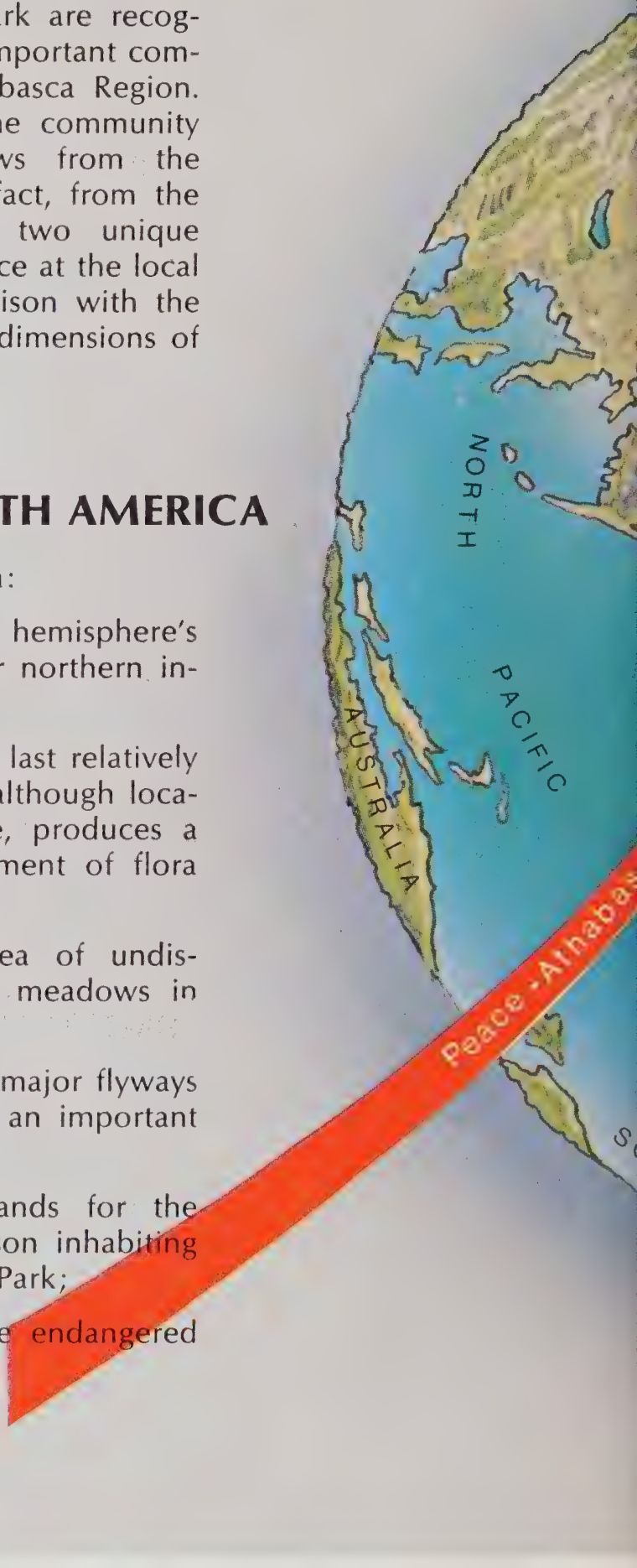
four

The Peace-Athabasca Delta and the Wood Buffalo National Park are recognized as two of the most important components of the Lake Athabasca Region. The essential nature of the community of Fort Chipewyan grows from the characteristics of, and in fact, from the very existence of these two unique entities. Yet their significance at the local level is modest in comparison with the national and international dimensions of their value.

IN TERMS OF NORTH AMERICA

The Peace-Athabasca Delta:

- is one of the western hemisphere's most extensive boreal or northern inland deltas;
- is one of the continent's last relatively undisturbed deltas, and although located in a northern clime, produces a varied and rich environment of flora and fauna;
- contains the largest area of undisturbed sedge and grass meadows in North America;
- is a key link in the four major flyways for migratory birds, and an important breeding area for ducks;
- provides the grazing lands for the major part of 14,000 bison inhabiting Wood Buffalo National Park;
- is a nesting area for the endangered peregrine falcon.




PACIFIC OCEAN
NORTH AMERICA
NORTH POLE
EUROPE
NORTH ATLANTIC OCEAN
SOUTH AMERICA
SOUTH ATLANTIC OCEAN


PEACE RIVER
SWEETGRASS LANDING
SWEETGRASS CR.
CLAIRE R.
WOOD BUFFALO NATIONAL PARK
BARIL RIVER
BARIL LAKE
PEACE RIVER
SCOW CHANNEL
SLAVE R.
REVILLON COUPE
CHENAL DES QUATRE FOURCHES
RIVIÈRE DES ROCHERS
PRAIRIE R.
MAMAWI LAKE
HILDA LAKE
LAKE CLAIRE
EMBARRAS RIVER
EMBARRAS PORTAGE
ATHABASCA RIVER
WILLOW POINT


AERIAL MOSAIC
PEACE-ATHABASCA DELTA
JULY, 1972
Aerial Photography by Canadian Armed Forces
Altitude 33,000 feet
Produced by Mapping Office, Surveys Branch, Department of Highways and Transport, Edmonton Alberta
BUSTARD ISLAND
ATHABASCA
LAKE
ORT
HIPEWYAN
FLETCHER CHANNEL
CHIPEWYAN
INDIAN
RESERVE
201
GOOSE ISLAND CHAN.
BIG POINT CHAN.
RICHARDSON
LAKE
MAYBELLE R.



NORTH AMERICAN MIGRATORY

PEACE-ATHA

The Peace-Athabasca Delta is unique in being situated on all four major flyways of the North American Continent.

SOURCE: "Waterfowl Tomorrow"
U.S. Department of the Interior

PACIFIC FLYWAY

Mallard, pintail, American widgeon, gadwall, green-winged teal, cinnamon teal, blue-winged teal, shoveler, greater scaup, lesser scaup, ring-necked duck, canvasback, redhead, common goldeneye, Barrow's goldeneye, bufflehead, ruddy duck, 3 species of mergansers, 3 species of scoters, snow goose, Ross' goose, white-fronted goose, Canada goose, black brant, whistling swan, trumpeter swan, American coot.

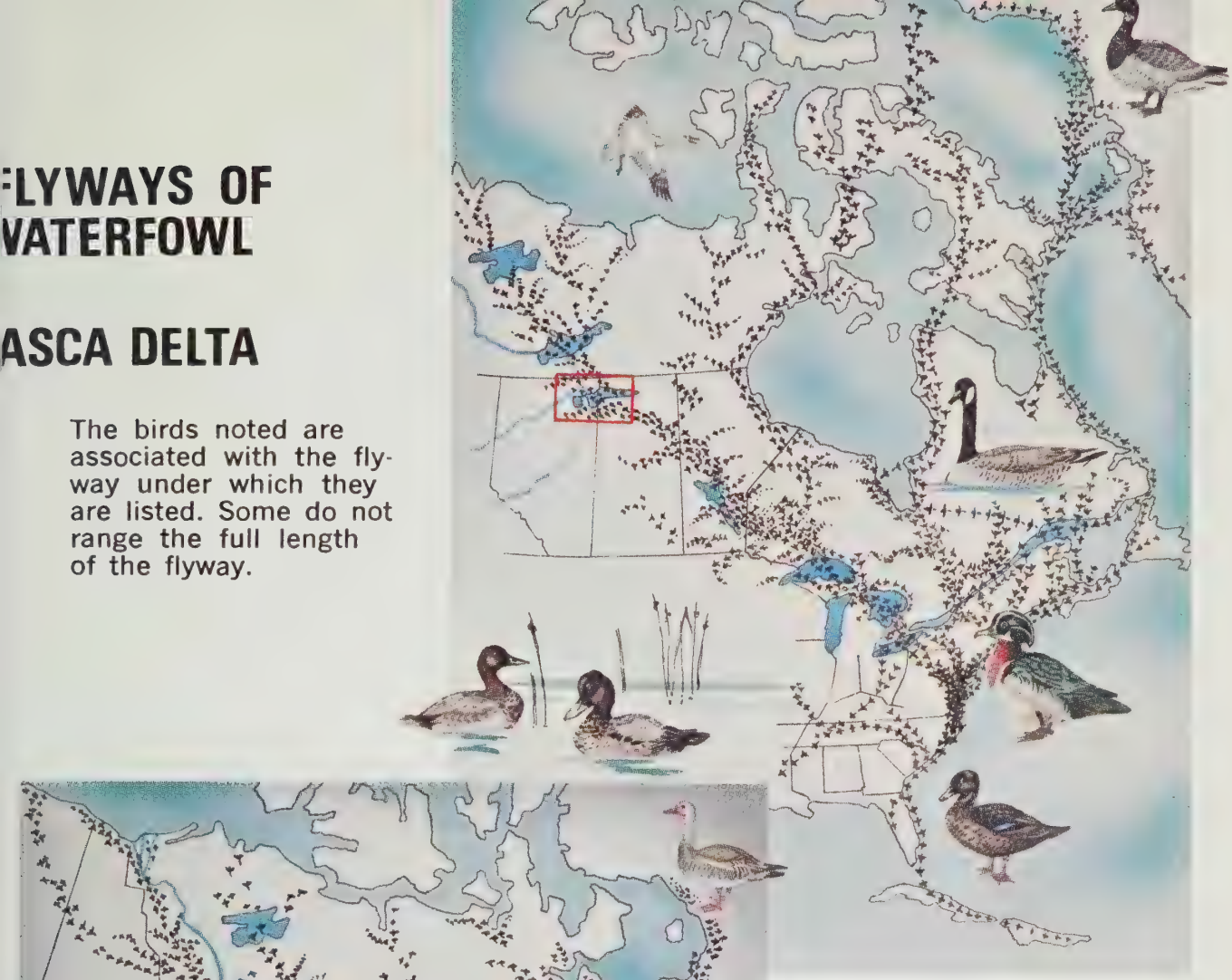
CENTRAL FLYWAY

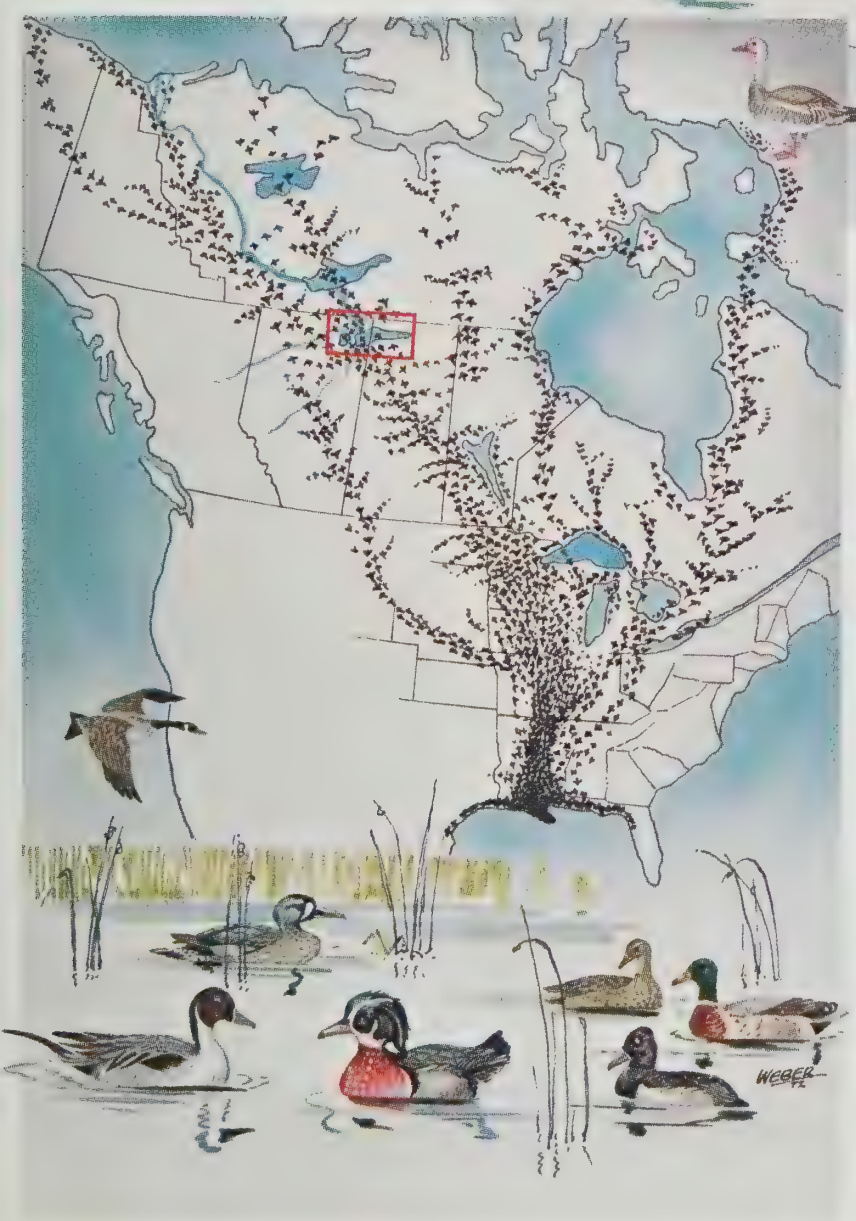
Mallard, pintail, green-winged teal, blue-winged teal, shoveler, American widgeon, gadwall, wood duck, common goldeneye, redhead, canvasback, lesser scaup, ring-necked duck, bufflehead, harlequin duck, hooded merganser, common merganser, ruddy duck, Canada goose, white-fronted goose, lesser snow goose, trumpeter swan, whistling swan, American coot.

FLYWAYS OF WATERFOWL

ASCA DELTA

The birds noted are associated with the flyway under which they are listed. Some do not range the full length of the flyway.





ATLANTIC FLYWAY

Black duck, wood duck, mallard, green-winged teal, American widgeon, blue-winged teal, gadwall, pintail, shoveler, greater scaup, lesser scaup, ring-necked duck, canvasback, redhead, common goldeneye, bufflehead, ruddy duck, harlequin duck, 3 kinds of mergansers, 3 kinds of eiders, 3 kinds of scoters, old squaw duck, American coot, Canada goose, American brant, greater snow goose, whistling swan.

MISSISSIPPI FLYWAY

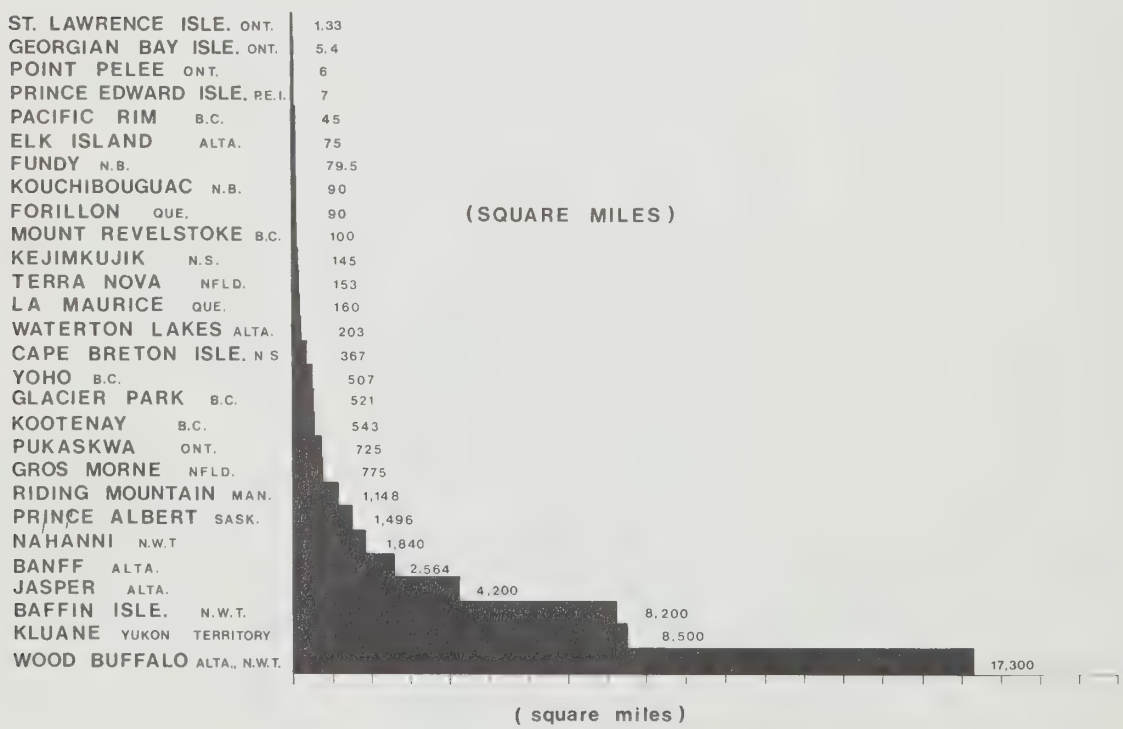
Mallard, pintail, wood duck, ring-necked duck, black duck, common goldeneye, mergansers, Canada goose, canvasback, blue and white phases of lesser snow goose, lesser scaup, blue-winged teal, white-fronted goose, gadwall, American widgeon, green-winged teal, shoveler, redhead, coot.

WOOD BUFFALO NATIONAL PARK
Its Importance To Canada

Wood Buffalo National Park with an area of 17,300 square miles is the largest national park in the world. It was established in 1922 to protect one of the few remaining herds of wood bison and other herds of plains bison.

The northern part of the Park is located in the Northwest Territories while the southern part is located in Alberta and includes 80 percent of the Peace-Athabasca Delta. In addition to the Delta, the Park contains three other significant topographic features: mountain uplands, glaciated plains and alluvial lowlands.

A wide range of wildlife is supported in the Park, including approximately 14,000 bison. Altogether, 45 species of mammals have been recorded here, including moose, caribou and black bear. More than 200 species and sub-species of birds frequent the Park. Most of these birds are summer residents and are species familiar to bird watchers in western Canada and the northern United States.



NATIONAL PARKS OF CANADA ACCORDING TO AREA

Nesting in the Park of the near-extinct whooping crane is of dramatic interest. Sixteen nests, the largest number on record, were counted in 1972. The 1971 whooping crane population was 82, including about 20 in captivity.

The National and Historic Parks Branch has summarized the importance of the Delta as a part of the Park in the following terms:

1. (Here we have) the unique quality of a large freshwater Delta which is preserved in a National Park, the only one of its kind in North America. The merging of aquatic and terrestrial ecosystems in the form of this Delta represents a unique biological community of national and international importance.

2. The Delta is one of the largest, most important waterfowl nesting and staging areas in North America, and consequently has international significance.

3. The Delta region supports a large portion of the world's largest free-roaming herd of bison.

FORT CHIPEWYAN
Its Regional Importance

The region has traditionally been the centre of activities in northeast Alberta and northwest Saskatchewan. Lake Athabasca has been, and will continue to be, vital to regional water transportation and fishing.

Located on Lake Athabasca, adjacent to both the Delta and the Park, Fort Chipewyan is the major service centre in the western part of the Lake Athabasca Region and, should a secondary service centre for the Park be required, the town is in a strategic location. The reservoir of manpower in the community could be vital to developments in the region.

Important historical and cultural considerations flow from the fact that Fort Chipewyan has played a key role in the early development of the North and is a part of the Canadian heritage.

Culturally, it is still the home of 1500 native people, many of whom, because of the isolation of the community, still speak in their native tongues.



E. HENNAN PHOTO



low waters and their impact



PEACE - ATHABASCA DELTA

COMPARISON OF LAKE SURFACE AREA IN 1955 AND 1970

MILES

5 0 5 10 15

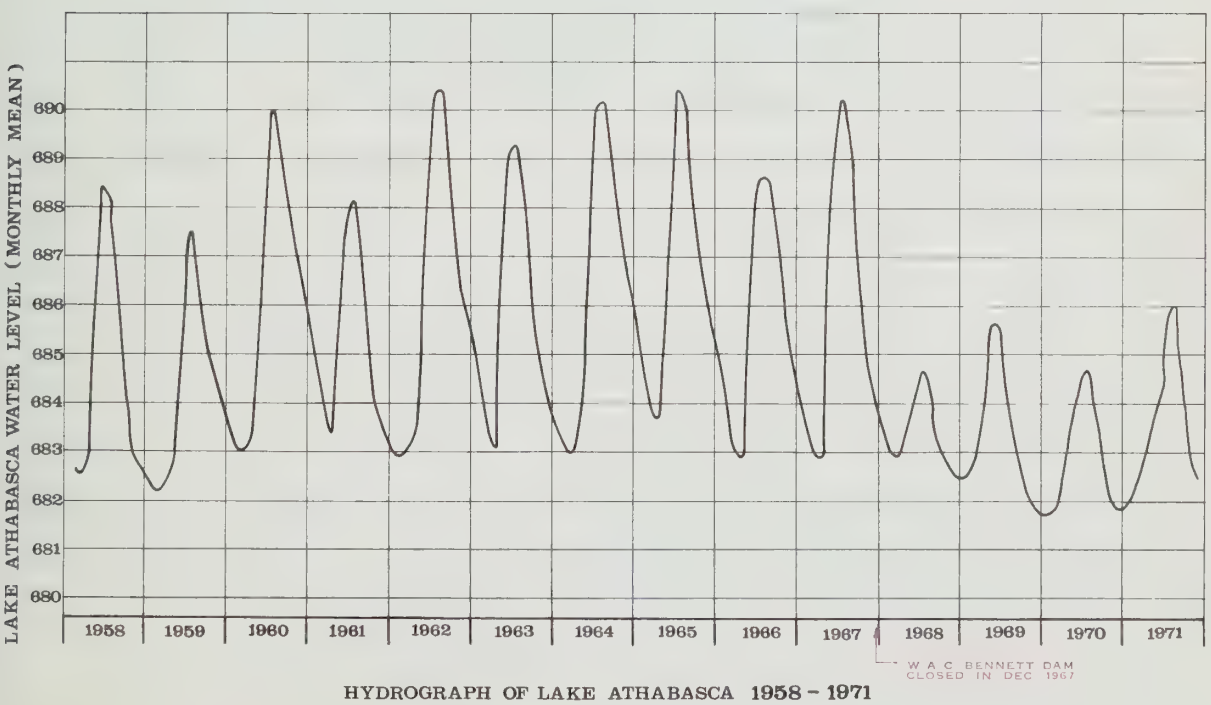
Recently Exposed Lake Bottom

five

CHANGES IN LAKE ATHABASCA LEVELS

In the summer of 1968 Lake Athabasca failed to rise to its usual mid-summer level. After reaching a peak of 684.6 feet, about four feet below the estimated long-term average for mid-July, the waters soon began to recede without any appreciable flooding of the Delta. Actually, this low mid-summer level was almost five feet below levels that had been established in the preceding 10 years, levels which had come to be accepted as normal for Lake Athabasca.

One season of minimal flooding on the Delta was not considered a catastrophe, but, for three more successive years, low mid-July levels persisted, with peak heights of only 685.8 feet in 1969, 684.6 in 1970, and 686.5 in 1971. In all this time, four summers in a row, there was no significant flooding on the Peace-Athabasca Delta.



HYDROGRAPH OF LAKE ATHABASCA 1958 – 1971

Deprived of its normal water supply for several seasons, the delicate balance of its ecosystem radically disturbed, the Delta landscape began to change. By 1970, as water levels declined in the Delta lakes and perched basins, more than 125,000 acres of mud flats became exposed and the inevitable process of plant succession was able to progress unchecked.

Records indicate that similar periods of low water levels have occurred in the past. Midsummer levels in the two-year period of 1816 and 1817 were five and seven feet respectively below the long-time average, while for three years, 1867 to 1869, water levels were again very low, dropping to a calculated level of 681 in 1868, almost eight feet below the established average.

Inevitably, though, such low levels have been followed by years of high water that have balanced off plant succession trends commenced by low water. As long as this balance is maintained, the early successional habitat types will continue to occupy a major portion of the Delta, and the high productivity of the region will be perpetuated. But without this age-old balance, the Delta will become a very different place indeed.

The Cause of Low Water Levels on the Delta

The cause of persisting low water levels in Lake Athabasca was the critical point to be determined by the project's hydrological study.

Clearly the problem must be largely attributed to the reduction in flood flows in the Peace River since 1968. Just as clearly, this reduction in Peace River floods is the direct result of the regulation of river flows by the W.A.C. Bennett Dam. One quarter of the Peace River drainage basin, which contributes 50% of the river flow, lies above this dam. So, although it is located some 700 miles upstream of the Delta, the Bennett Dam effectively controls 50% of the flow in the Peace River at its point of influence on Lake Athabasca.

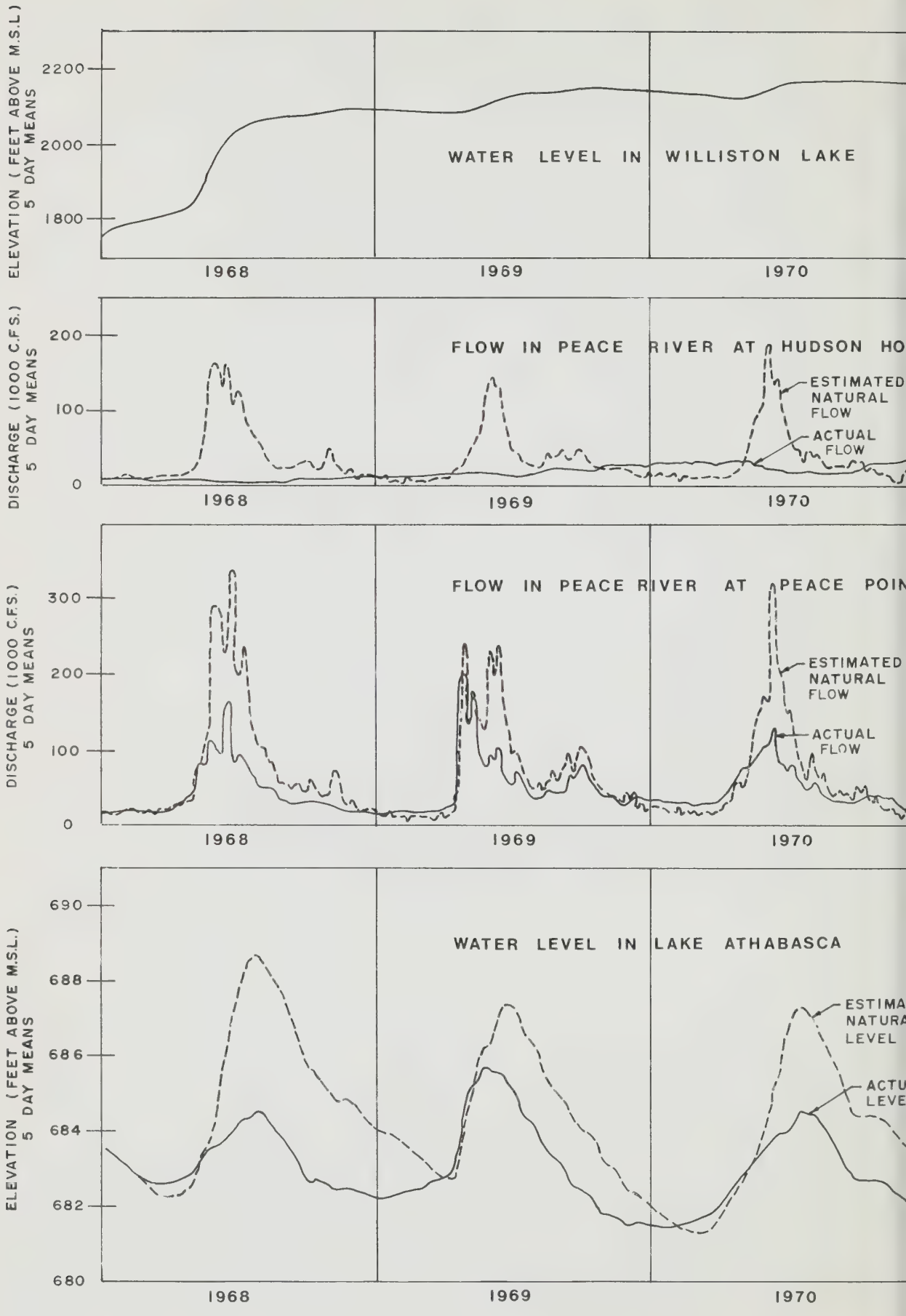
Since 1968, this reduction in flows has been particularly severe, due to the initial filling of Williston Lake, created by the dam. During this time 50,000,000 acre-feet of Peace River waters have been stored in this lake. The effect on downstream flows and water levels is shown in the accompanying hydrographical charts on pages 70 and 71.



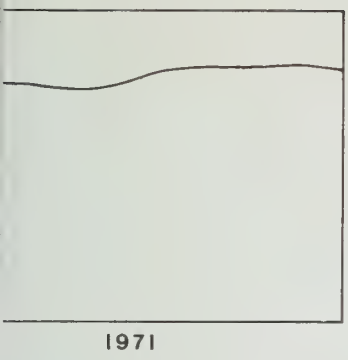
CANADIAN WILDLIFE SERVICE PHOTO

Large areas of exposed lake bottom, Lake Mamawi in July of 1970.

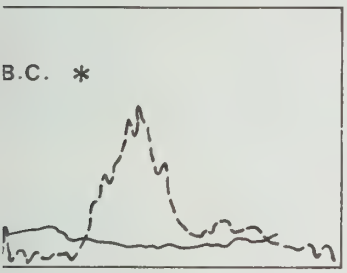
Flood flows on the Peace River at Peace Point were reduced by as much as 200,000 cubic feet per second, and river levels were 10 to 12 feet lower than usual at flood time. At such low levels the Peace River no longer provided a natural barrier to the outflow of water from Lake Athabasca during the flood season. Spring floodwaters from the Athabasca and Fond du Lac Rivers, normally stored in the Lake and raising its summer water levels, were permitted to flow out of the Lake at a much more rapid rate than usual, and Lake Athabasca failed to rise to the levels of other years.



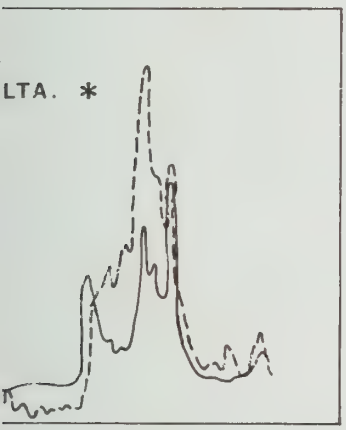
M.S.L.—Mean Sea Level
C.F.S.—Cubic Feet Per Second



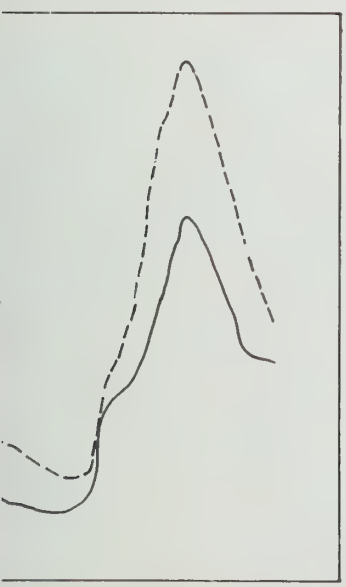
1971



1971



1971



1971

LAKE LEVELS AND RIVER FLOWS DURING THE FILLING OF WILLISTON LAKE, 1968-71

The reduction of flows on the Peace has been especially significant since 1968, due to the initial filling of the Williston Lake behind the dam. During the four years between 1968 and 1971, there has been a net storage in this lake of 50 million acre feet. The effect of this upon the downstream flows and water levels is shown in this chart, which illustrates the volume of water in Williston Lake, the flow in the Peace River at Hudson Hope, B.C., downstream from the dam, and at Peace Point, Alberta. The recorded water levels and flows are shown as a solid line, while the dotted lines illustrate the estimated flows and levels which would naturally have occurred had the Bennett Dam not been in control of the upper Peace River.

Note that the flood flows on the Peace River at Peace Point were reduced by as much as 200,000 cubic feet per second, reducing river levels by 10 or 12 feet in the reaches which affect the Delta.

*See map, page 82

During this four-year period Lake levels averaged 2½ feet lower than normal, and the Delta waters, dependent on the Lake waters, declined in a similar manner. Although 2½ feet may not appear to be a great reduction in the level of a body of water as large as Lake Athabasca, this decline produced marked reductions in the volumes and water-surface areas of the lakes in the flat Delta region. Here, a small variation in Lake Athabasca levels can be the crucial factor that determines each season whether or not water will be restored to the Delta lakes.

In the illustrations on pages 70 and 71, the difference between the two Lake Athabasca hydrographs illustrates the computed effect of the Bennett Dam on the Lake during the filling of the Williston reservoir. However, it should be noted that in 1969 and 1970 the Lake levels would have been somewhat lower than normal, regardless of the regulatory effect of the Bennett Dam, since runoff in the Athabasca River was below average in these years. On the other hand, the Athabasca River reached a very high flow in the spring of 1971, but even this was not sufficient to correct conditions in the Delta to any degree.

EFFECTS OF LOW WATER LEVELS

Changes in Vegetation

Vegetation responded very quickly to the sudden alteration in water levels. Many seeds germinated in the first year that receding waters left mud flats exposed. Seedlings of grasses, sedges, willows and a number of annuals appeared. The cycle of plant succession had begun, and by 1971, new meadows and willow communities were becoming well established in their second or third year of growth. What successional route these new plant communities will take depends on whether Delta water levels rise appreciably, remain at approximately constant heights, or continue to decrease.

Major changes also began in the well established Delta sedge and grass meadows. Since sedges require water at or above ground level during much of the growing season, the decline of water caused some of the sedge meadows to die out. With temporary flooding during part of the growing season, the *Calama-*



These photos from another northern delta, the Saskatchewan River Delta, graphically illustrate the consequences of plant succession.

Photo 1,
taken June, 1968.



Photo 2,
taken July, 1968.



Photo 3,
taken August, 1968.

This sequence clearly shows the reasons for the concern of ecologists with respect to vegetation succession in the Peace-Athabasca Delta. Low waters expose the mud flats underlying the former lake areas and permit the rapid growth of seedlings.

DUCKS UNLIMITED PHOTOS

grostis or grass meadows are able to maintain vigorous root systems which prevent willow seedlings from becoming established. Without this flooding, *Calamagrostis* loses its hold and willow takes over. Although, during the short time-period of this study, it was not possible to document the extent of permanent willow invasion, there is no doubt that the 10 to 15-year successional transition toward dominant willow communities has already begun.

Effects on Waterfowl

June and July flooding of the Delta sweeps away many duck nests during the incubating season. Hatches do improve in seasons of little or no flooding at this critical nesting period. However, without the usual flooding in the summers of 1968 to 1971, the perched basins and their shorelines, so vital to breeding ducks, have been rapidly drying up. In the three years following 1968, approximately 36 percent of the perched basin shoreline disappeared and there was a reduction of more than 38 percent in the water surfaces of these basins. Should they dry up and become overgrown with vegetation, they will be of little value to breeding ducks, and even should they eventually be flooded again, their particular character will have been irreversibly altered.

Waterfowl moulting habitat, serving as escape cover for these flightless birds, was reduced during the four-year dry period, as mud flats appeared between the new shorelines of perched basins and small lakes and the emergent marsh vegetation that had originally surrounded them.

As for staging waterfowl, the abundant mud flats and shallow waters created by the low water levels have temporarily extended the feeding grounds for migrating ducks and geese, which prefer the seedlings and seeds of annual plants typical of early succession growth on mud flats.

Effects on Muskrat Population

During the winter of 1968-69, following the first season without midsummer flooding, the muskrat catch in the Park portion of the Delta was 38,000 pelts. In 1970-71 it decreased to 8,000. The 1971-72 winter harvest in the Park was under 2,000. A large number of the marshes that had previously supported muskrat houses had become too shallow for the animals to overwinter successfully.

An examination of muskrat houses, commenced in March of 1971, showed that the muskrat's chances of survival increased with the depth of the water in which its house was built.

The following table shows the animal's chance of survival in relation to the depth of water:

DEPTH OF WATER	PERCENTAGE OF MUSKRAT SURVIVING IN WINTER
0.0-1.0 feet	30
1.1-2.0 feet	41
2.1-3.0 feet	52
3.1-4.0 feet	61

This study confirmed that low water was the main reason for the disappearance of muskrat in many of the perched basins. In seventy percent of the basins examined, water depths had dropped to less than two feet.

In the fall of the same year, Project staff made the first known census of muskrat and muskrat houses on the Delta. Approximately 8,000 houses and bank runs were found and the fall population was estimated at 40,000 animals. This population was severely depleted during the winter and by March of the following spring only 17,000 muskrat remained on the Delta. This was an extremely low population for a marshland area of this size and it clearly points out the unsuitability of successive years of low water for the muskrat population.

Stable water levels of two or more feet in depth, maintained throughout the winter in marshes that support abundant vegetation, provide acceptable survival conditions for the muskrat community. The larger Delta lakes, Claire and Mamawi, do not provide the constant water levels required, since their waters either recede during the winter or are already too low by freeze-up time. It is the deeper, restricted drainage basins that are capable of holding water and supporting muskrat through the winter. Almost annual recharging of these perched basins by midsummer floods during the early 1960s accounted for the large muskrat populations which provided the Delta trappers with such bountiful catches in those years.

It is interesting to note that the low water levels of the past four years have caused a redistribution of plant life toward the

lower contour levels of the marsh fringes. This condition is analagous to the planned partial "drawdowns" on managed muskrat marshes, a technique used to re-establish favorable vegetation that has been drowned out by high water. Once the vegetation has been established, the marsh is flooded again and then maintained at a winter level deep enough for the muskrat, but shallow enough for the growth of healthy stands of emergent vegetation. A return, now, of high water levels in the Delta, should they reach peaks high enough to refill the perched basins at regular intervals, would make available to the muskrat thousands of acres of new emergent plant growth.

Effects on Bison and Moose

The lack of midsummer flooding on the Delta, although it may have improved calf survival, has had little immediate effect on the bison herd inhabiting Wood Buffalo National Park. If low water levels continue, however, it is evident that plant succession will proceed to the point where willow communities will eventually replace the abundant sedge and grass meadows of

Approximately 300,000 acres of meadow support half the world's bison population.

L. ALLISON PHOTO



the Delta, where most of the Park herd now grazes. Remaining grazing habitat in the Park might not, in that case, support the sizable herd now protected within the Park.

Moose prefer the more mature habitats, which have not been affected to any degree by the reduced water levels and so changes in the Delta have had little effect on the moose populations.

Effects on Fish Population

Fishery studies, carried out through 1971 and 1972, were required to determine the effects of the changed water regime upon the fish populations of the area. These studies centred mainly on goldeye and walleye, and to some extent on lake trout.

Observation of goldeye revealed that the 1971 water levels in the Chenal des Quatre Fourches and the Prairie River were adequate for the goldeye to reach Lakes Mamawi and Claire to spawn. It has been concluded that the 1971 spring and fall levels, which remained quite low at elevations 684 to 685 feet in Lakes Claire and Mamawi, appear to be the absolute minimum to allow the migration of goldeye.

Despite the commonly held belief that Lake Athabasca walleye spawned in the Maybelle River, studies found that Richardson Lake is a major spawning area for walleye. In years of low water, when Lake Richardson could freeze to the bottom, walleye would have difficulty and could be prevented from entering to spawn until after the spring breakup. In such cases the walleye spawning run could be seriously disrupted. At this time it is not possible to conclude whether the 1971 spawning run can be considered successful. Further monitoring of walleye spawning runs and age analyses of these fish in the next three or four years will be necessary to determine how extensive are the effects of low water upon the reproduction of walleye.

During the recent years of low water in Lake Athabasca, the winter drop has been only about one foot below the level at freeze-up time. As pointed out earlier, the critical period for lake trout egg survival is over the winter months, during which an appreciable decline in lake levels would have an adverse effect. It appears, then, that water levels have not dropped low enough to be harmful to lake trout reproduction.



E. HENNAN PHOTO

Low water levels on Lake Athabasca cause problems in the use of some docking facilities.

Effects of Low Water Levels on Navigation

The most serious effect appears to be the significant increase in dredging operations required in Big Point Channel on the Athabasca River portion of the Delta. Some dredging has always been necessary here to assist water-borne freight into Lake Athabasca. Between 1958 and 1967 the dredging in Big Point Channel averaged 95,000 cubic yards. Between 1968 and 1971 yardage increased to roughly 201,000 cubic yards. Since 1968, it has been necessary to work the dredges almost full time in the Big Point Channel. Cost of this work in 1970 amounted to $130,000.

In addition, 19 more navigational aids have been required at various locations on Lake Athabasca, to indicate shoals which become dangerous at low water levels. The total cost of such aids was approximately $14,000.

Low water at Big Point Channel was not the only difficulty reported. The Northern Transportation Co. Ltd. has also experienced shallow-draft problems in the Chenal des Quatre Fourches, principally at the confluence of this river and the

Peace River. Here, shifting sand bars due to low water have held up barge traffic and the reverse flow conditions at this location have shifted the deep-water channel from one side of the river to the other. Dredging would not alleviate this problem to any great extent.

Docking difficulties were encountered at Fort Chipewyan and several other points. In cases of shallow water, the tugs and loaded barges have had to ramp up to dock level. Delays in freight handling of this kind added considerably to normal costs. Under favorable water levels, barges could be loaded to a maximum draft of 5 feet, but with the recent low water conditions, the draft has been restricted to 3.5 feet for most of the navigation season. This again increases the operating costs of the freighting companies.

E. HENNAN PHOTO





GOVERNMENT OF BRITISH COLUMBIA PHOT

THE STORY OF THE BENNETT DAM

The history of the W.A.C. Bennett Dam goes back to 1956, when the Province of British Columbia signed an agreement with the Swedish Wenner-Gren firm to conduct resource and development surveys in northeastern British Columbia, including the upper Peace River basin. A major result of this survey was the 1959 Feasibility Report on the Peace River Hydro-Electric Project, which indicated the possibility of building two hydro-electric generating facilities on the Peace River, just west of Hudson Hope. Together, the two sites would have a potential electrical output of 3,185 megawatts of power, equivalent to 4¼ million horsepower.

In August 1961, the government of the province acquired ownership of the B.C. Electric Company and the Peace River Power Development Company, which had been formed as a result of the Feasibility Report. The newly formed Crown corporation, the B.C. Hydro and Power Authority ordered an immediate start on the upstream site and designated it the Portage Mountain Development. This project became the W.A.C. Bennett Dam, the Gordon M. Shrum Generating Station, and Williston Lake. The larger of the two hydro electric facilities outlined in the 1959 Feasibility Report, it was constructed with a capacity to produce 2,270 megawatts of power (3 million horsepower).

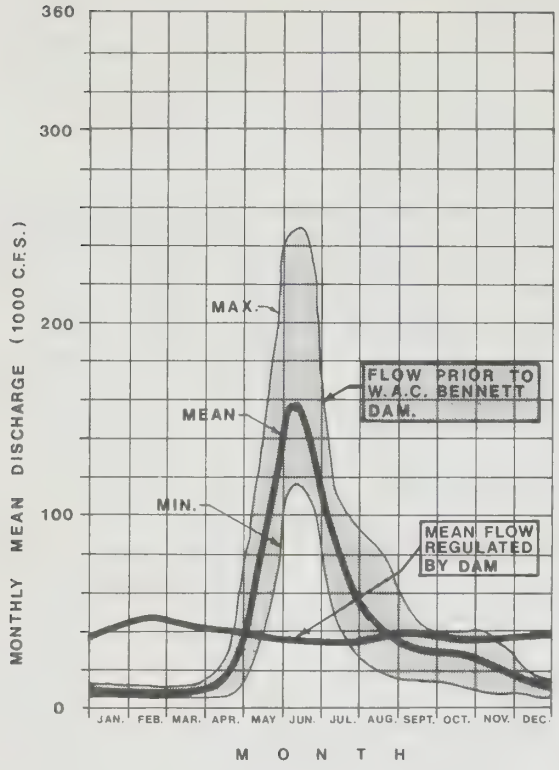


GOVERNMENT OF BRITISH COLUMBIA PHOTO

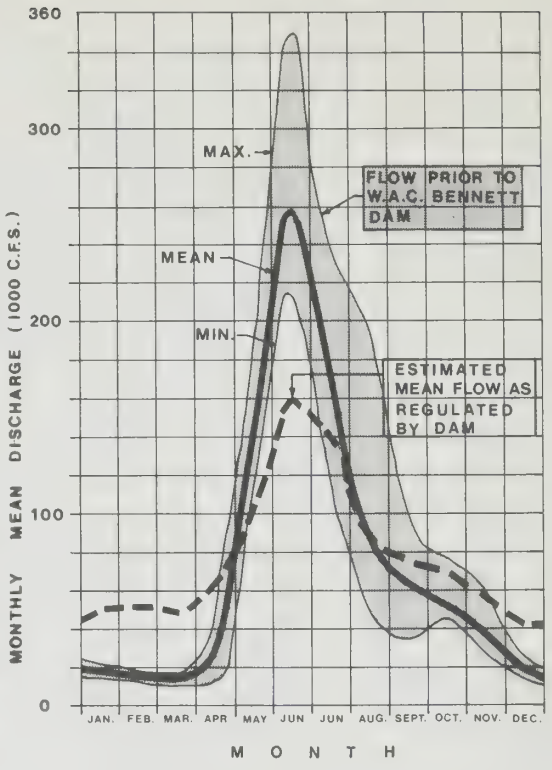
The Bennett Dam, 600 feet high, creates Williston Lake which has a volume of 57,000,000 acre-feet of water. It is one of the world's largest man-made lakes, covering an area of 635 square miles, and over 200 miles in length. The dam, also one of the largest of its type in the world, contains some 57,000,000 cubic yards of fill material and is termed a zoned earth-fill type of dam.

The Shrum Generating Station is an underground powerhouse about the size of three football fields with an ultimate complement of ten generating units, each with a nameplate rating of 227 megawatts. At present, seven of the ten units have been installed and normal procedure requires five of the units to be in operation at any one time. Each unit discharges about 6,000 cubic feet of water per second when in operation. In addition to discharges from the generating station, water can be released by the W.A.C. Bennett Dam over the main spillway. The rate of discharge is dependent upon the reservoir level, but with the reservoir at its maximum operating elevation of 2,205 feet, the spillway could pass approximately 250,000 cubic feet per second.

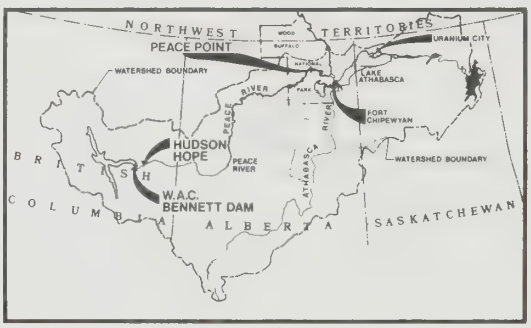
It took about 5½ years to build this power complex, and as construction reached the final stages in December of 1967, the dam was closed and the upper Peace River came under the control of man.



Peace River flows at Hudson Hope B.C.



Peace River flows at Peace Point Alta.



FUTURE FLOWS ON THE PEACE RIVER UNDER REGULATION OF THE BENNETT DAM

It is now quite evident that, in the future, the former low-winter flows on the Peace and the high summer levels resulting from the high snowmelt runoffs of May and June, will be eliminated. Operating plans for the Bennett Dam and Shrum Generating Station call for the release of flows at a fairly constant rate of 36,000 cubic feet per second throughout the year. Possible additional spring releases in some years when the reservoir is filled, combined with the flows contributed by tributaries, will not be sufficient to prevent a very marked deviation from past flow patterns in the Peace River.

Calculations of Lake Athabasca water levels under the modified regime, when adjusted to reflect long-term averages, reveal that:

- With flows in the Peace River modified by the Bennett Dam, Lake Athabasca summer levels can be expected to average about elevation 686.
- This is about one foot lower than the summer average elevation of 687 under the natural regime.
- Average summer maximum levels will reach only elevation 686.5. This is two feet lower than the average elevation of 688.5 for the summer peaks under the natural regime.

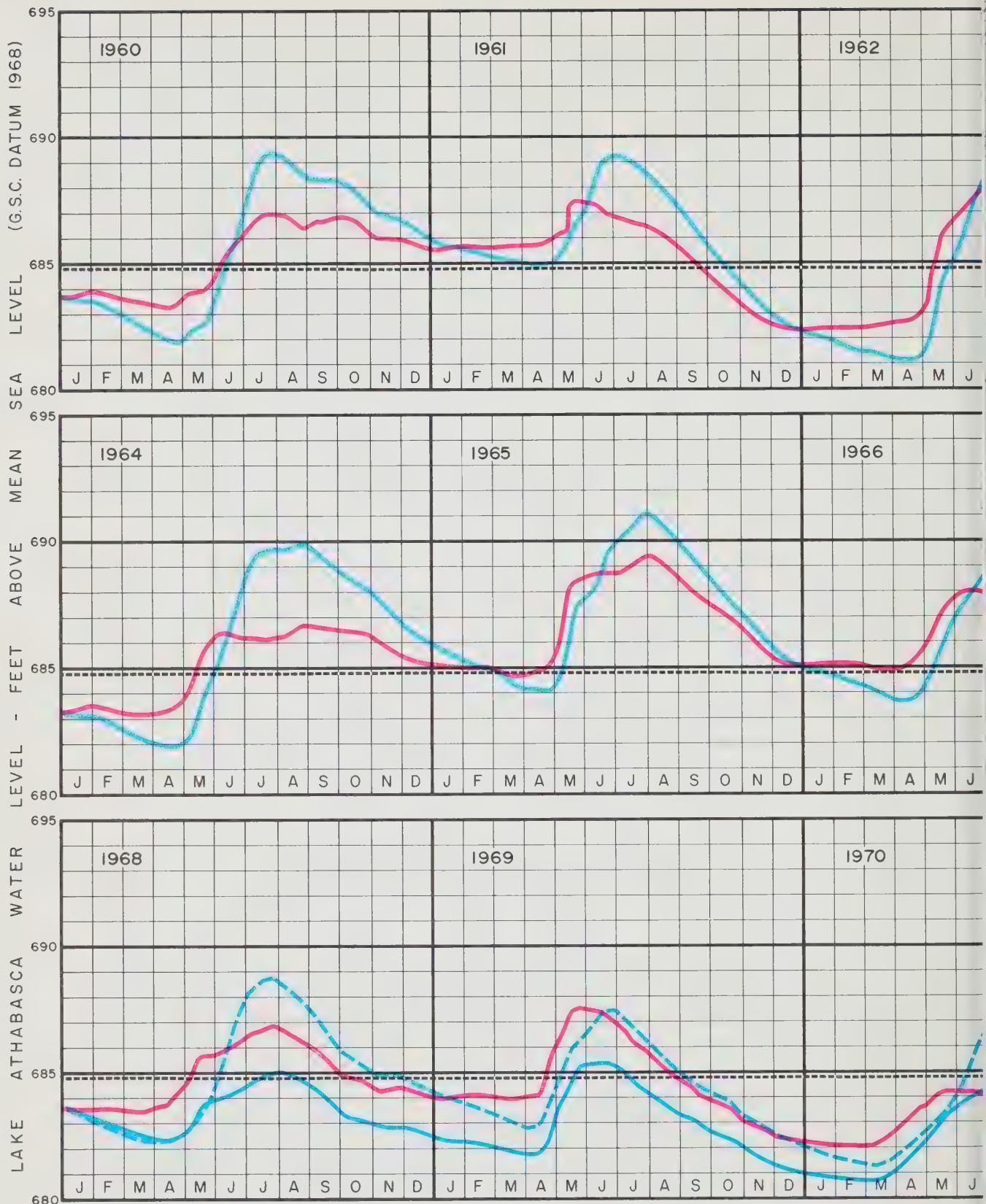
Lake water levels of this order are not sufficient to flood the Delta.

PREDICTED EFFECTS OF MODIFIED REGIME

What further effects can be expected from the modified water regime, imposed by full operation of the Bennett Dam, upon the complex ecosystem of Delta rivers, lakes, marshes, meadows and mud flats? Changes in the Delta will be extensive:

- Almost 297,000 acres of existing meadow will eventually be replaced by shrub communities.
- Plant zones will gradually shift to lower elevations around lake margins, advancing plant succession that has already commenced on the mud flats.
- Ranges of the early succession plants such as sedges and grasses, will be reduced by as much as 50 percent.
- Most of the perched basins will not be filled as often as in the past. As their water levels retreat through evaporation and transpiration, plant succession will continue uninterrupted for longer periods and willow or other shrub communities will become firmly established before flooding occurs again.

Aging of the Delta, a process always in progress, but always in the past checked to some extent by flooding, will now be



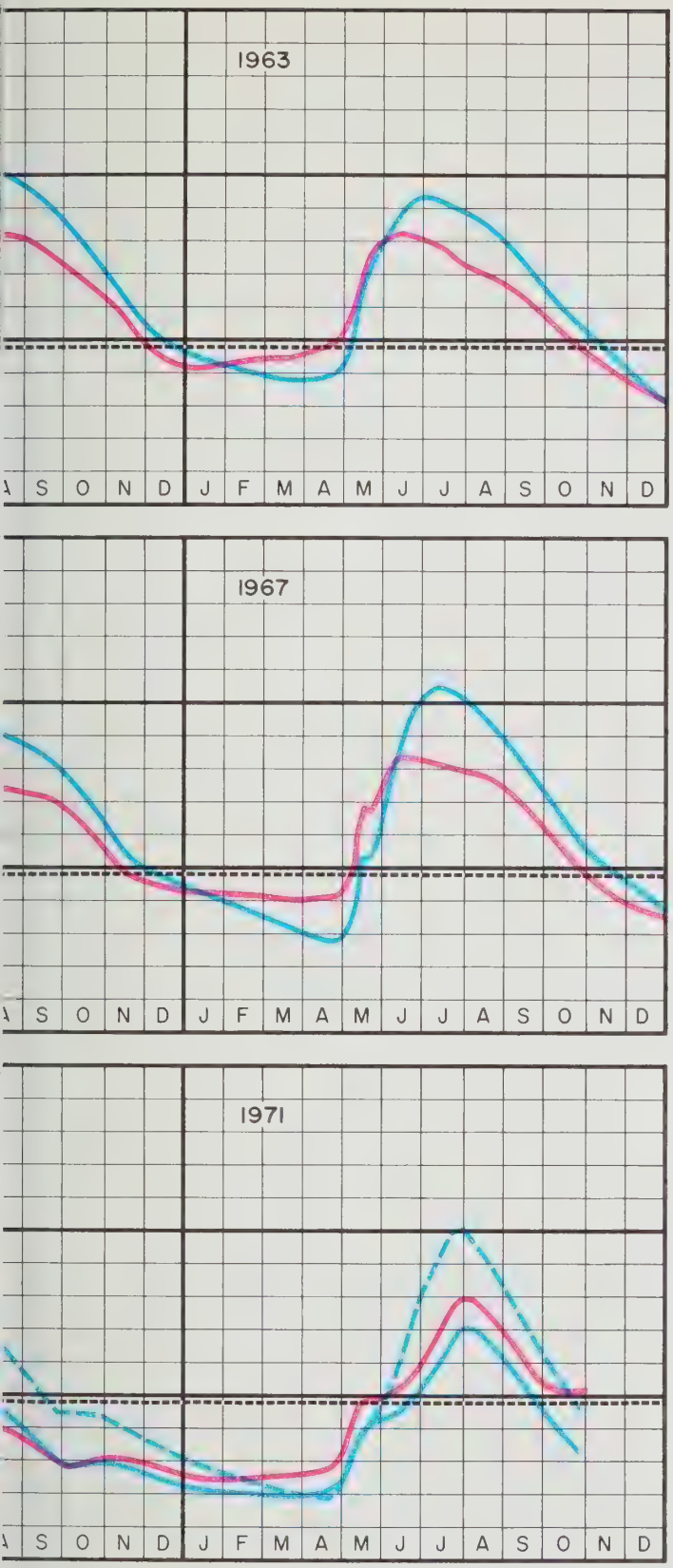
LEGEND:

- **Observed lake levels**
- **Estimated lake levels assuming no effect by Bennett Dam 1968 to 1971**
- **Modified lake levels assuming full operation of Bennett Dam**

All Hydrographs derived from computer simulation model

- **Approximate average annual lake level (1930 to 1970)**

NOTE: Observed levels 1968 to 1971 occurred during the initial filling of Williston Lake and hence are lower than the modified levels.



LAKE ATHABASCA HYDROGRAPHS, SHOWING OBSERVED WATER LEVELS, MODIFIED WATER LEVELS AND AVERAGE ANNUAL WATER LEVELS.

Knowing the anticipated changes in the Peace River flow, it is possible to calculate the effect of the operation of the dam upon the water levels of Lake Athabasca. The first step is to assume that the dam has been operational in the period 1960 to 1971, and to determine the resulting or "modified" lake levels in that period. This period is the only time span in which there are sufficient streamflow records to use in the calculation of lake levels.

Within this 12-year period, calculations of the effect of the dam show peak water levels to be reduced by as little as 0.7 feet, in 1966, to as much as 3.7 feet in 1964, with an average reduction in peaks over the 12-year period of 2 feet. Average summer water levels are reduced 1 foot. Winter levels, however, are increased over the period by about 1.5 feet, because of the greater winter discharges. Two other periods of time are of interest, that of spring water levels and also the fall water levels at freeze up. Again, over the 12-year period, the mid-May water levels would average 1.5 feet higher with operation of the dam, but the mid-October levels would average 0.7 feet lower.

The water levels used in the foregoing analyses have been compared with longer-term water level records back to 1930, and with a calculation of Lake Athabasca levels dating back to 1810. The latter levels are based upon an analysis of tree ring widths from trees in the Delta area. The comparisons indicate that the average water levels in the 12-year period were approximately one foot higher than those of the longer 157-year period. With this adjustment taken into account, average summer lake levels will be 686 under the modified regime, and this is 1 foot lower than the average for the natural regime of 687. The average of the annual maximum lake levels will be 686.5 under the modified regime, 2 feet lower than the 688.5 feet of the natural regime.

greatly accelerated. Continued absence of flooding, permanent reduction in Lake levels, and persistently low summer peak levels will surely result in a very significant decrease in the acreages of habitats that support the wildlife of the Delta.

Wood Buffalo National Park was established to preserve and display the dynamics of nature. The predicted ecological changes, being artificially induced, present a marked departure from the conditions of nature.

Effects on Wildlife

The modified regime will not seriously affect the staging habitat for migratory birds. Although less mud flats will be available in the fall, because of a slow decline in water levels, there will still be ample resting and feeding areas for the fall migrations. Lower mid-summer water levels will reduce the number of nests lost due to flooding and improve waterfowl hatches in the Delta, but loss of shoreline due to the infrequent filling of the perched basins will gradually reduce the total nesting area around the perched basins. Prediction of the future effect of reduced flooding and loss of breeding area on waterfowl production, although incomplete, indicates that the loss of breeding area will cause a downward trend in the waterfowl produced in the Delta.

A definite improvement in the production of birds on the Delta could be effected by a change in regime that would recharge the basins before or after the nesting season. Such management would minimize the destruction of nests by flooding and help to maintain the perched-basin shorelines as nesting grounds, effectively increasing waterfowl production.

Because of the lower winter levels in the perched basins and marshes, future muskrat populations will be smaller than under natural conditions, but not as small as occurred during the last four years. Whether or not future populations could support sustained trapping is very questionable. Restoration of natural conditions would bring about an improvement, while the development and management of the muskrat marshes would ensure a dependable production.

A reduction in the abundant sedge and grass meadows of the Delta, where most of the Park bison now graze, will not endanger existing herds, but some readjustment in grazing patterns may evolve.

Since the reduced water levels of the modified regime are not expected to fall below 1971 levels, goldeye populations are not likely to be affected. Spring levels of the Quatre Fourches at breakup will be adequate for these fish to enter Lakes Mamawi and Claire for spawning. Walleye, however, could have difficulty in entering Richardson Lake for spawning until after breakup, and this may curtail production severely. In this case, the planned increase in fishing on Lake Athabasca might seriously reduce the walleye population in the Lake. The lake trout population is unlikely to suffer under the modified regime.

Navigation

The effect on navigation will not be as serious as in the 1968-71 period. Reduced fall drafts, just under one foot, will mean lower freight tonnages than usual for the pre-1968 days. Spring drafts under the modified regime will be improved. The intensive dredging programs carried out over the last four years will likely be required.

Effects on Recreation and Tourism

It is the appeal of the Delta as a unique, unspoiled wilderness that creates its future potential value for recreation and tourism. An appreciable change in the present character of its plant and animal communities could reduce this appeal. The possibility of guided canoe tours along some of the Delta's more interesting and scenic channels, lakes and marshes would be lost if low water levels and ecological succession are allowed to continue.

The potential for recreation and tourism development around the east end of Lake Athabasca, in Saskatchewan, is limited and very few possibilities exist.

THE NEED FOR ACTION

The Peace-Athabasca Delta is a truly irreplaceable Canadian resource. Its complex ecosystem, constantly changing in nature's age-old rhythms, continuously undergoing subtle mutations, is held in delicate balance by the annual rise and fall of the waters from which it grew. Now, the imposition of a new, man-made water regime has disrupted the ancient pattern and put into motion forces of change that will greatly accelerate the aging of one of the few remaining large wetland Deltas on this continent. The question today is whether we can allow this process to continue unhindered, or whether we should act quickly to reverse the course upon which the ecosystem has now embarked. The decision must be made soon.

Modification of the natural regime under the influence of Bennett Dam operations will, in time, bring about

- a major redistribution of the Delta's plant communities, favoring less productive terrestrial growth;
- a decrease in diversity, as manifested in shore edge; a decrease in muskrat population;
- a decrease in waterfowl production;
- an increased hazard to sustained reproduction of the walleye of Lake Athabasca.

What is the impact of these changes? Upon the answer to this question must be based the need for action.

Certainly they will affect people. They will affect people in Fort Chipewyan who still depend on fishing and trapping to augment their incomes. They will affect present and future generations for whom Wood Buffalo National Park has been preserved as a national heritage. And while it is most difficult to define the social values implicit in the protection of the Park and the Delta, they are of major importance to the Canadian people.

Other more tangible considerations must also be examined in assessing the need for action. A number of jurisdictions are involved. Lake Athabasca lies partly in Alberta and partly in Saskatchewan. The Delta lies in part within Wood Buffalo National Park, partly in Alberta and in part within the Chipewyan Indian Reserve No. 201. The purposes, objectives and requirements of all must be considered. There is no doubt that different approaches to resource management, different wildlife, migratory birds and tourist regulations and different economic objectives are in conflict here.

The intent of the National Parks policy is preservation of the Park, insofar as possible, in its natural state. Only limited management is permitted, and that oriented only toward the maintenance of natural conditions within the Park. Provincial and other federal agencies may adopt policies for more intensive management of the Delta. Any decision for action must consider all of these various aspects.

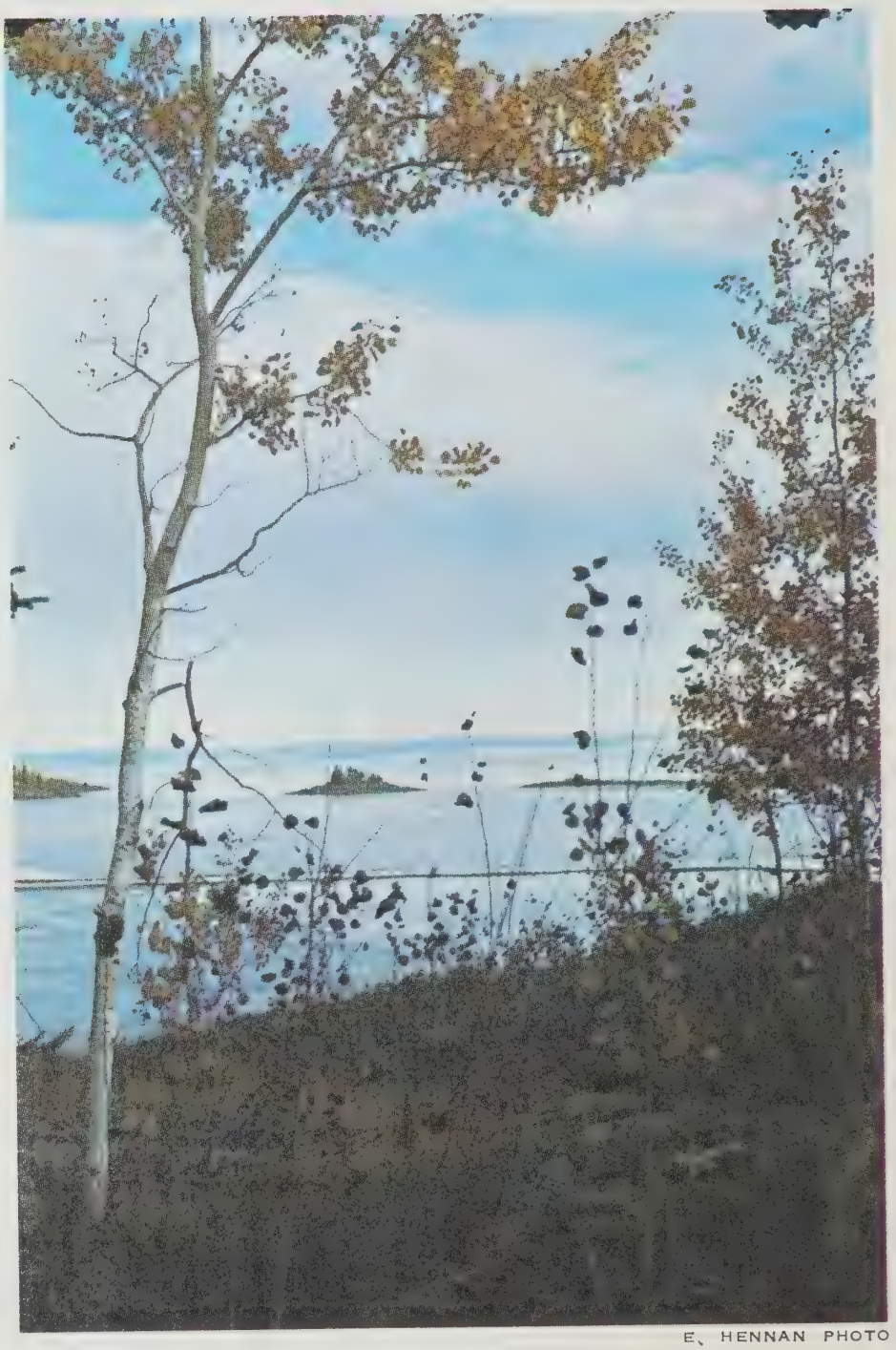
The choices are four:

1. The modified water levels imposed by the Bennett Dam and the premature aging of the Delta may be accepted.
2. Remedial works may be constructed to restore the natural water levels in the Delta.
3. Intensive management of the Delta may be undertaken, involving compartmentalization and the construction of physical works to manipulate water levels in order to effect a sustained production of one or more of the wildlife resources.
   In this case it would be possible to increase the harvestable populations of certain wildlife species above the numbers which would be produced under either the natural or modified regimes.
4. The natural regime may be restored and, in addition, supplemental works constructed to permit sustained production of resources in specific areas.

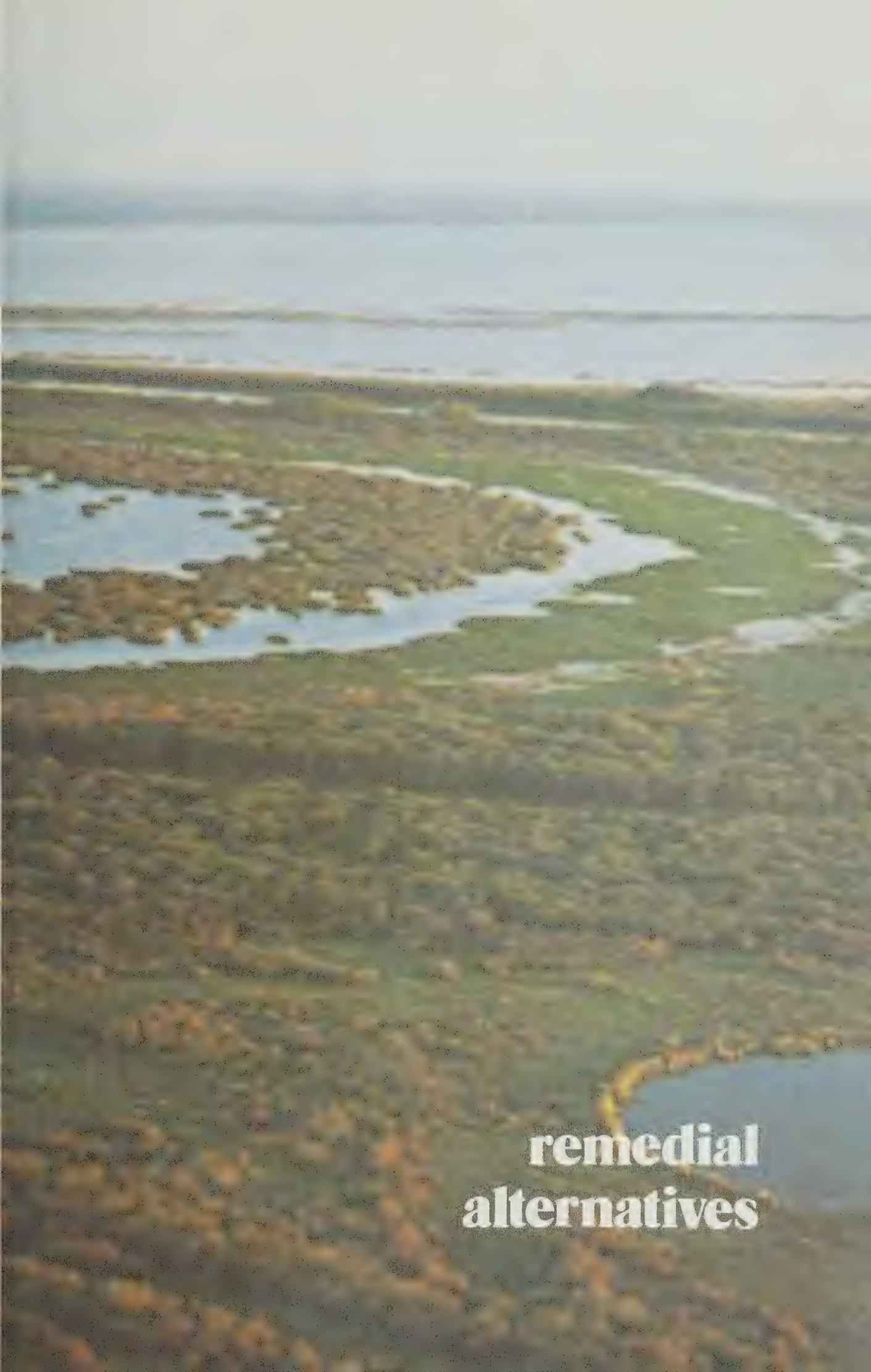
It is evident that major ecological changes are occurring in the Delta. These changes will continue in future under the modified water levels. The national and regional impact of the loss of Park values, the loss of habitat for migratory birds, the loss of trapping and of possible fishing, combined with navigation problems, supports the need for action.

The course of action to be taken must consider the responsibilities and objectives of the governments involved. Intensive management for the Delta would be contrary to the National Parks Policy.

Nature has produced an eminently productive ecosystem in the Delta. It is therefore proposed that the minimum action should be to restore the water levels of Lake Athabasca in order to re-establish the ecological conditions in the Delta which occurred under nature.



E. HENNAN PHOTO


remedial
alternatives

six

REMEDIAL MEASURES

Some action for the preservation of the Peace-Athabasca Delta has already been taken by the governments concerned. In the fall of 1971 a rockfill dam was constructed on the western arm of the Quatre Fourches to improve water levels in the Park portion of the Delta. In the summer of 1972 the Governments of Canada and Alberta completed a diversion-control project on the Athabasca River to prevent it from eroding through its banks and joining with the Embarras River. This was necessary to reduce the possibility of major changes occurring in the Peace-Athabasca Delta.

In addition, the local people took action to construct several small dams on the Chipewyan Indian Reserve to improve the muskrat habitat and conserve the muskrat population of these marshes.

QUATRE FOURCHES DAM

The initial assessment of the changing conditions in the Delta had made it clear that immediate action was necessary to halt the progress of ecological succession that had commenced during the previous four years of low water. The Quatre Fourches Dam was adopted as a temporary measure until a more permanent solution could be determined. The dam, consisting of a rock-fill plug, was constructed at the outlet of Mamawi Lake, at a cost of $200,000.

The purpose of this dam is to impound water from the Birch River basin to raise the water levels of Lakes Claire and Mamawi, and of adjacent ponds and perched basins. The Peace River can overtop its banks and also flood the northern part of the Delta during high flood flows and ice jams in the spring. This, too, can help to improve the water levels of Lakes Claire and Mamawi and of the perched basins along the Peace. The success of the temporary dam, therefore, depends on the amount of runoff from the Birch River and the frequency with which the combination of high floods and ice jams might occur on the Peace River.



E. HENNAN PHOTO

The west arm, Quatre Fourches impoundment, constructed in the fall of 1971.

Recognizing these considerations, a flexible approach was adopted in the design and construction of the Quatre Fourches Dam. In the fall of 1971 the dam was completed to an elevation of 684 feet. At this height water could still flow in from Lake Athabasca, should high lake levels occur. In the spring, the Dam was completed to elevation 688.5 and temporary arrangements were made for the passage of goldeye and other fish.

Effects of the 1972 Spring Flood on the Delta

The spring of 1972 brought a substantial runoff in the Birch River which helped fill Lakes Claire and Mamawi to very acceptable levels of 688.5 feet. Also, fortuitous ice jams on the Peace River created high river levels that caused a significant volume of water to overflow its banks into the Delta, filling all the perched basins north of Lake Claire and also raising the level of Baril Lake to 689 feet. The impoundment structure at Quatre Fourches held the inflowing water at the desired level

and prevented the rapid recession of the lakes which otherwise would have occurred without the dam.

Later, heavy early summer rainstorms in the Smoky River basin, and in the headwaters of the Peace, produced a flow that caused the Peace River to rise to approximately 689 feet at its confluence with the Rivière des Rochers. This high river level, combined with a substantial inflow to Lake Athabasca from the Athabasca River, caused the lake level to rise to elevation 688.5 feet in July.

Through this combination of fortunate occurrences, water levels in Lake Athabasca and the Delta in 1972 approached the normal summer levels. These occurrences were rare events, however, and cannot be considered as typical conditions for the future. The flood on the Smoky River can be expected to happen only once in 500 years. Similarly, the appearance of two large ice jams on the Peace River is possibly a once-in-10 years event. A large ice jam at the right point, lasting for several days, can trigger a reverse flow on the Quatre Fourches and Rivière des Rochers, resulting in a considerable diversion of water into

Recent flooding in July of 1972 partially inundated the Delta, improving conditions in roughly 60% of the area.

G. TOWNSEND PHOTO




EROSION SEQUENCE ON THE
ATHABASCA AND EMBARRAS RIVERS
1945 - 1971
EMBARRAS
RIVER
1945
1971
1945
706
ATHABASCA
RIVER
1965
1945
707
706
708
200' sloped to pilot channel
Pilot channel 20' x 10'-15' deep
trees cleared both sides
Area graded down for river entrance.
ATHABASCA RIVER
DIVERSION CHANNEL
AS CONSTRUCTED

Lake Athabasca and the Delta. While such unpredictable events cannot be relied upon in resolving low-water problems, their possibility must be considered in any proposals for remedial works.

These unusual floods and ice jams have provided a short but important breathing period in which to consider action and construct works to restore the water levels of Lake Athabasca. Although the urgency has been reduced to some degree, the necessity for remedial action is still the paramount consideration.

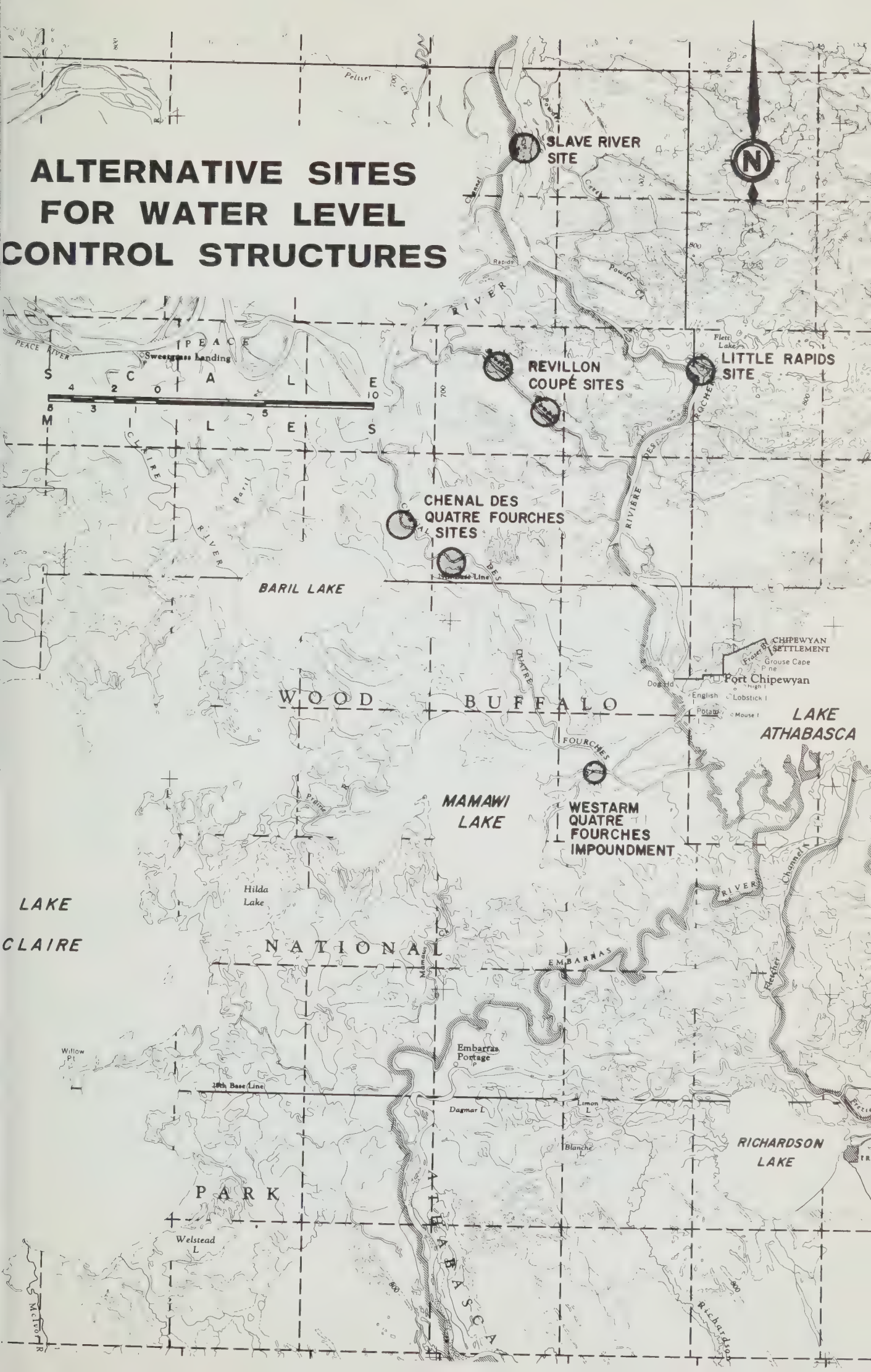
Water levels in Lake Athabasca remain the key to water levels in the Delta. Only by controlling the levels of Lake Athabasca is it possible to assure the Delta of sufficient water.

Diversion Control — The Athabasca River

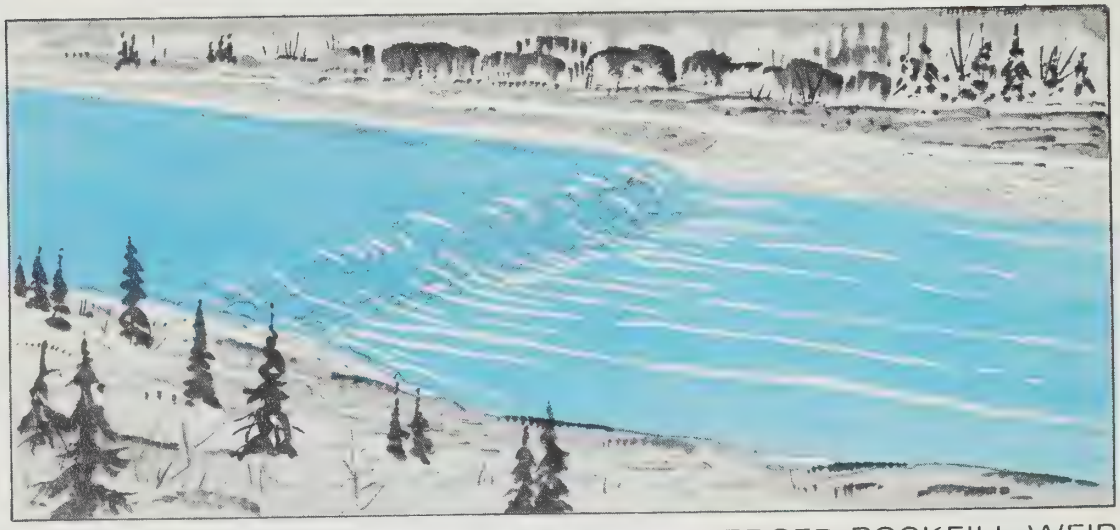
Considerable concern has been expressed about the possible undesirable effects of an impending breakthrough of the Athabasca River into the Embarras River, a condition created by natural forces and not connected to problems caused by the Bennett Dam. The map on page 95 indicates the location and nature of the problem.

The site is located about four miles upstream from the Embarras Portage. At this point a westerly-moving meander on the Athabasca River is within 116 feet of breaking through to the Embarras River. Aerial photographic records since 1927 show that erosion between the banks of these rivers has been proceeding at a rate of about 30 feet each year, with a recent increase that may have exceeded 45 feet in the past year or two. If the Athabasca River were to continue cutting its bank toward the Embarras, it would very soon join with the Embarras River. A less likely possibility is that the river might cut across the base of the meander, completely bypassing the eroding bank.

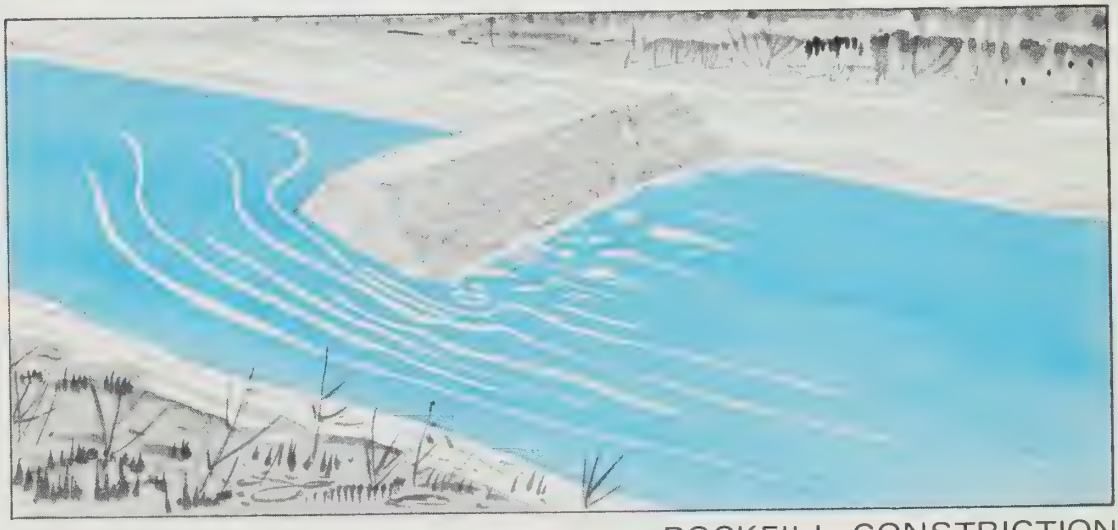
It had been predicted that the two rivers would join. This raised the speculation that if the waters of the Athabasca were to breach the far bank of the Embarras, all or part of the flow in the Athabasca would be diverted towards Lakes Claire and Mamawi. These are shallow lakes, either of which, in the course of a few years, would become filled with sediment. The Athabasca River then most likely would find a direct course to the Slave River through the existing Delta channels and bypass Lake


ALTERNATIVE SITES FOR WATER LEVEL CONTROL STRUCTURES
SLAVE RIVER SITE
REVILLON COUPÉ SITES
LITTLE RAPIDS SITE
CHENAL DES QUATRE FOURCHES SITES
WESTARM QUATRE FOURCHES IMPOUNDMENT
PEACE RIVER
Sweetgrass Landing
SCALE
MILES
CLAIRE RIVER
BARIL LAKE
RIVIÈRE DES ROCHERS
CHIPEWYAN SETTLEMENT
Port Chipewyan
WOOD BUFFALO
LAKE ATHABASCA
MAMAWI LAKE
LAKE CLAIRE
NATIONAL PARK
Hilda Lake
Embarras Portage
Dagmar L.
Limon L.
Blanche L.
Welstead L.
RICHARDSON LAKE
ATHABASCA
Peace
Pelissier
Powder Creek
Rapids
Fletts Lake
Grouse Cape
Pine
Dog Hd
English
High I
Lobstick I
Potato
Mouse I
Fraser R.
Prairie
Willow Pt
Fletcher
Channel
Richardson
Watson R.

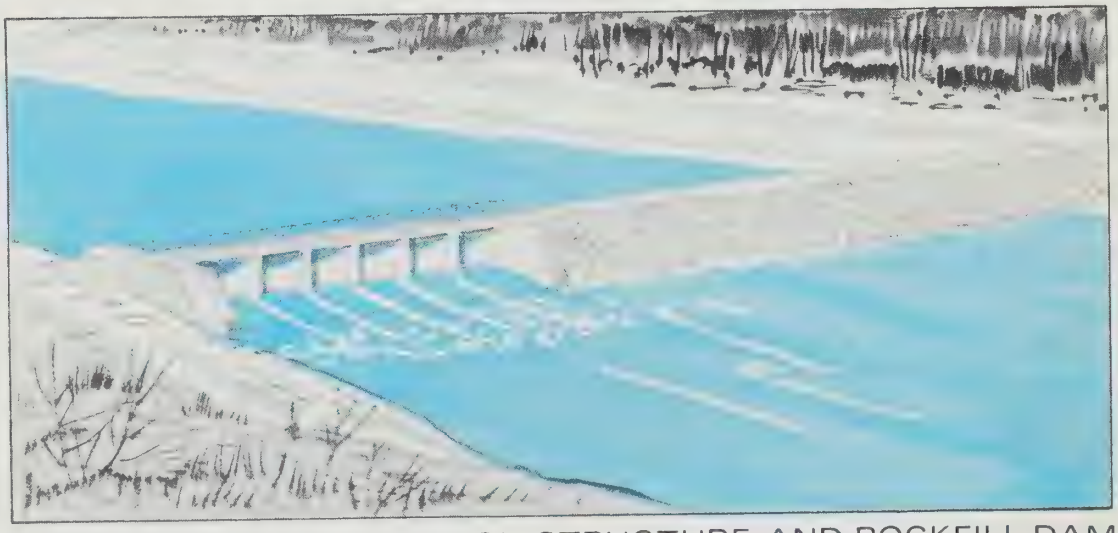
CONCEPTS OF CONTROL STRUCTURES



SUBMERGED ROCKFILL WEIR



ROCKFILL CONSTRICTION



GATED CONTROL STRUCTURE AND ROCKFILL DAM

Athabasca. If this were to happen, the Athabasca River would no longer deposit its rich load of sediment in the Delta flats. The Athabasca portion of the Delta would cease to grow. In a geological sense, the Athabasca Delta had reached an extremely unstable point in its existence. Only interference by man could allay, with any certainty, the possibility that it would become inactive.

Physical changes of this magnitude would completely alter the unique ecological characteristics of the Delta. Its value as a part of a national park would be drastically altered. The importance of the area for migrating birds could be greatly reduced. Navigation, trapping and fishing would also be affected.

For these reasons, during the summer of 1972 a channel was excavated across the base of the problem meander to divert the flow away from the eroding bank. Cost of the project was $155,000.

SELECTION OF MAJOR ALTERNATIVES

The assessment of the impact of low water levels, as discussed earlier, has defined the need for action. The minimum objective should be to restore the water levels of Lake Athabasca to those generally prevailing prior to the construction of the Bennett Dam.

Two concepts were studied for the artificial restoration of water levels on Lake Athabasca. Control dams to regulate the outflow from Lake Athabasca could be constructed on the channels which drain the lake. Or a control dam could be constructed on the Slave River to raise the water levels at the confluence of the Peace River and the Rivière des Rochers, and so regulate the flow out of Lake Athabasca. The latter would simulate the "hydraulic dam" effect which occurs during large flows on the Peace River. These methods of control can be appreciated by considering the configuration of the channels and alternative sites as shown in the accompanying map on page 97.

Permanent Works

The main sites for permanent works are the Slave River and Little Rapids in the Rivière des Rochers. Should a control be constructed at Little Rapids, an additional structure would be required to close the Revillon Coupé and another may be re-

quired to regulate the outflow in the Chenal des Quatre Fourches. Alternative sites on the Revillon Coupé and the Quatre Fourches have been identified on the map.

If the water levels of Lake Athabasca are restored, the temporary dam constructed on the Quatre Fourches will become redundant. Therefore, demolition of this dam must be considered when assessing the alternatives.

Three types of permanent works were investigated for the Slave River and Little Rapids sites. As shown in the illustration:

1. The submerged weir would consist of rockfill placed across the channel to control the flow.
2. The constriction would require a rockfill dam across part of the stream to reduce the outflow.
   Neither of these structures would require operation, and little maintenance would be necessary. Rock for construction could be obtained at the sites.
3. The gated control dam is a much more sophisticated means of maintaining the desired lake levels, but continuous operation and maintenance, and the assignment of operating responsibilities would be required.

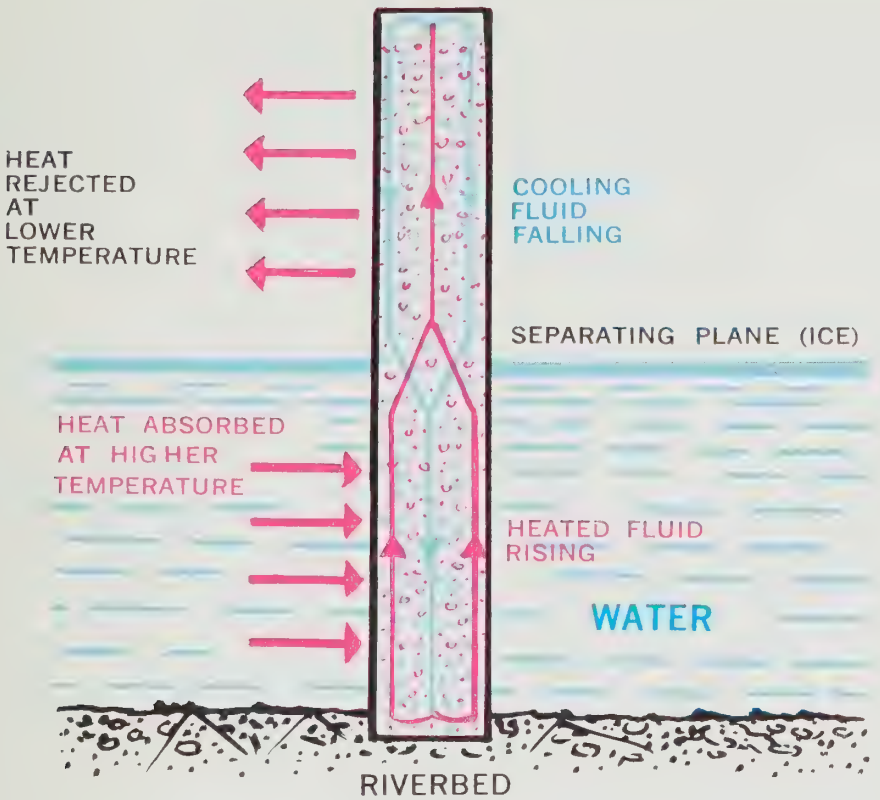
Ice Dam

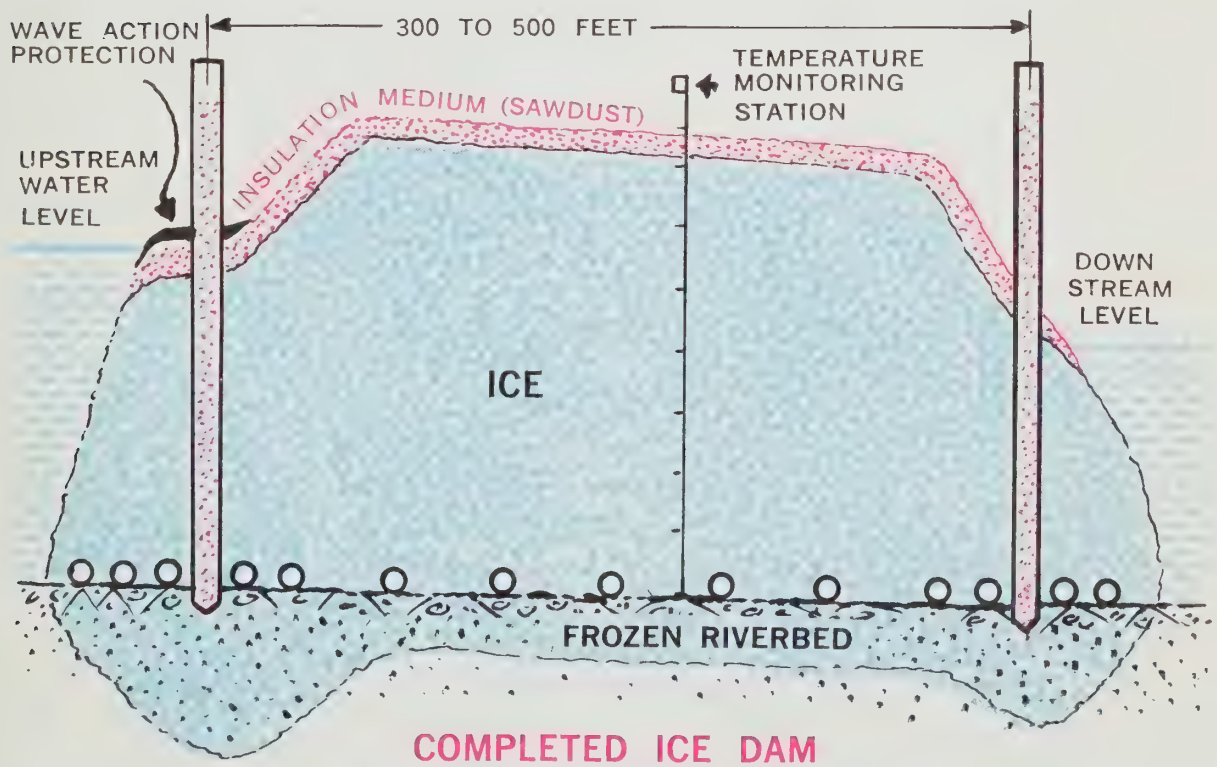
During the project, a pilot study on the feasibility of constructing a temporary ice dam on the Rivière des Rochers was also investigated. An innovative concept, this ice dam would completely fill the channel from January to July, when it would be destroyed.

Construction of such a structure would involve the use of a network of cryopiles to consolidate ice blasted from upstream. This would be protected with sawdust to maintain the ice mass until summer peak water levels were attained. 1972 field tests proved that this concept is feasible for producing the ice required to make the dam. The chief value of an ice dam lies in the fact that it would be removed, and so would not entail the commitment inherent in a permanent works. It must, however, be rebuilt each year that high water levels are desired, while during intervening years there would be no control of levels on the Delta and Lake Athabasca. The principles involved in constructing an ice dam are illustrated in the accompanying diagrams.

THERMOSIPHON PRINCIPLE

(FLUID CONVECTION)

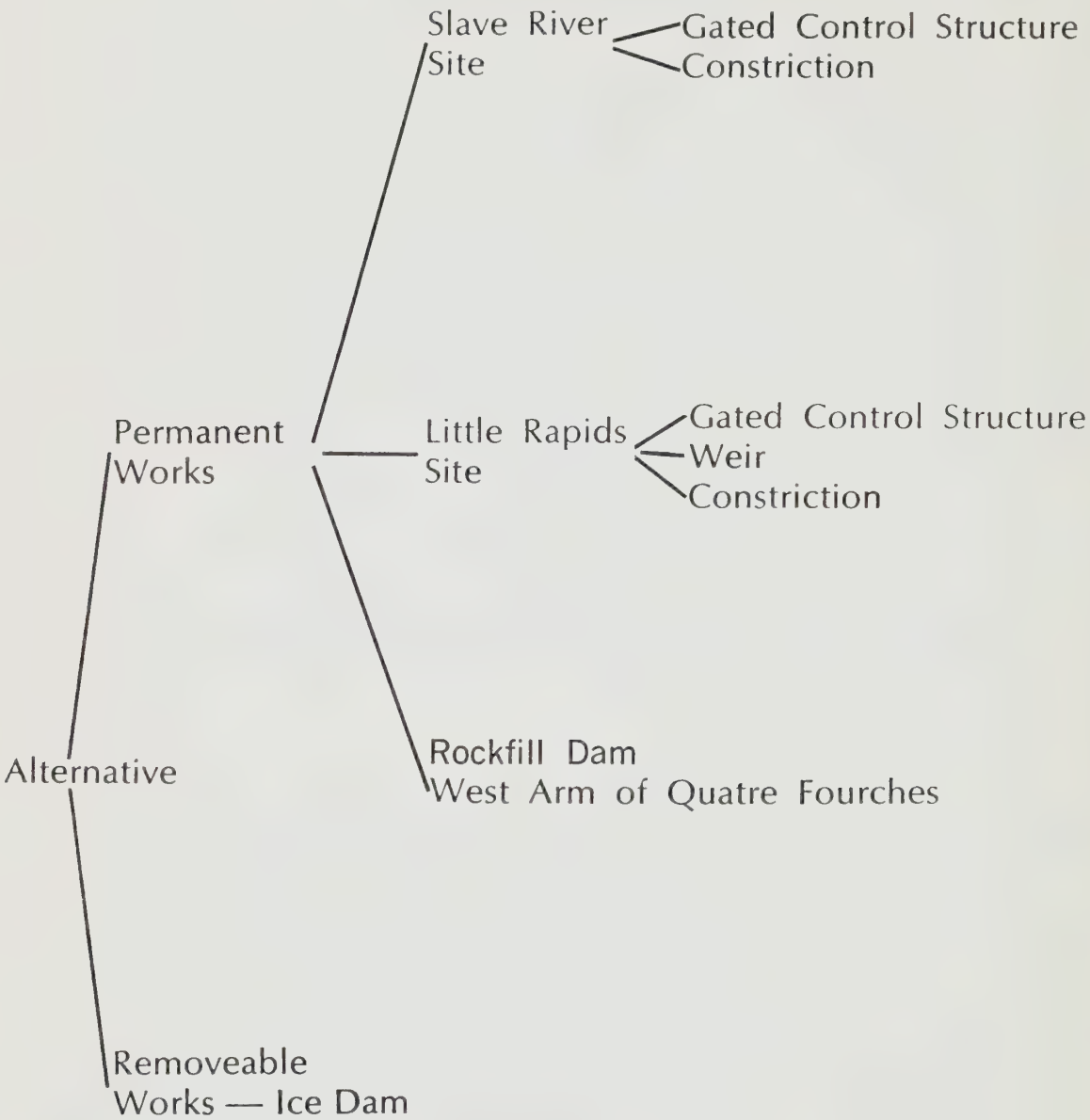




COMPLETED ICE DAM

Listing of Alternatives

The following sketch summarizes the major alternatives considered.



Two other possibilities were considered in identifying the alternatives. The first was the possible release of water from the Williston Reservoir to partially restore the historic flood peaks on the Peace River. This would require releases in the order of 200,000 cubic feet per second for a minimum of five days to significantly affect the level of Lake Athabasca. This would require releases of such magnitude that the scheme is considered quite unfeasible.

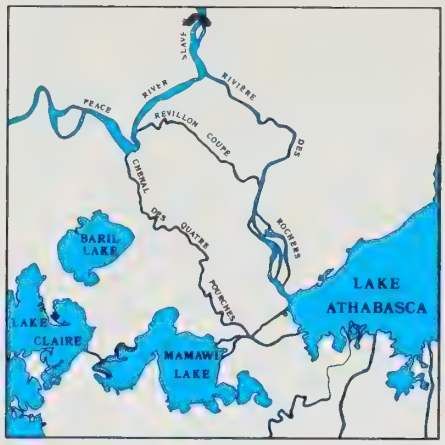
The second possibility pertained to the feasibility of restoring water levels in Lake Athabasca by utilizing the reservoir that would be created should a power dam be developed at Mountain Rapids on the Slave River. However, there appear to be no immediate plans for proceeding with this project. Further, it is highly improbable that the method of regulating the reservoir levels of such a dam would be compatible with requirements for Lake Athabasca. For these reasons, and because of the urgency involved, this possibility was dropped.

ASSESSMENT OF ALTERNATIVES

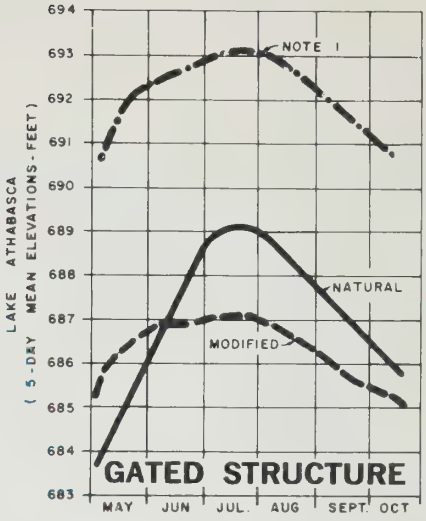
Ten key factors were considered in evaluating the alternatives:

- simulation of the natural lake levels
- passage of fish
- downstream effects
- operating decisions required
- flushing of Delta lakes
- navigation requirements
- ice problems
- deposition of sediment
- effects on channel regime
- costs

SLAVE RIVER

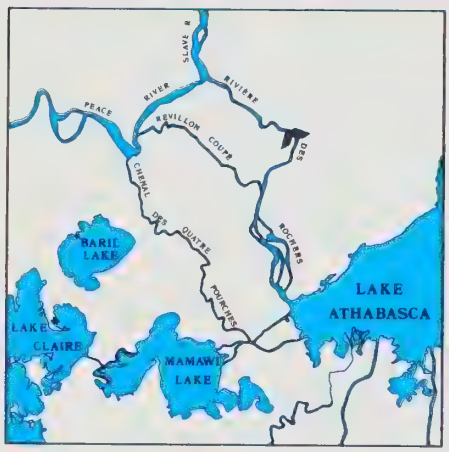


- Silt deposition and flushing action restored
- Fish ladder required
- Locks required
- Ice problem

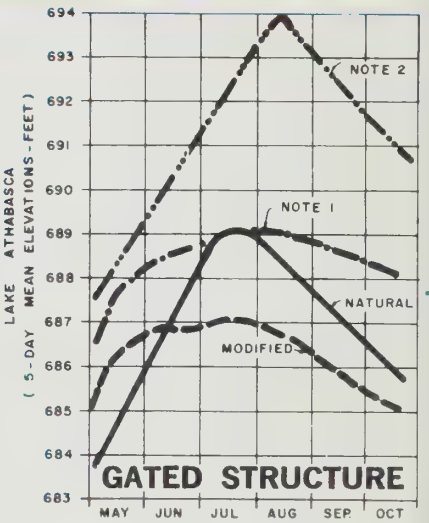


- Operation required
- Ice problem
- Cost: $20,000,000

RIVIERE DES ROCHERS

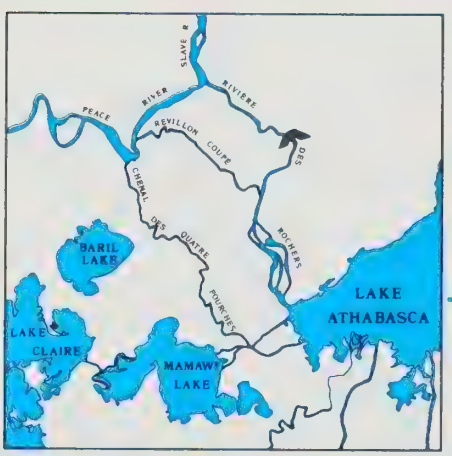


- Silt deposition and flushing action partially restored
- No fish ladder required
- No locks required
- Ice problem

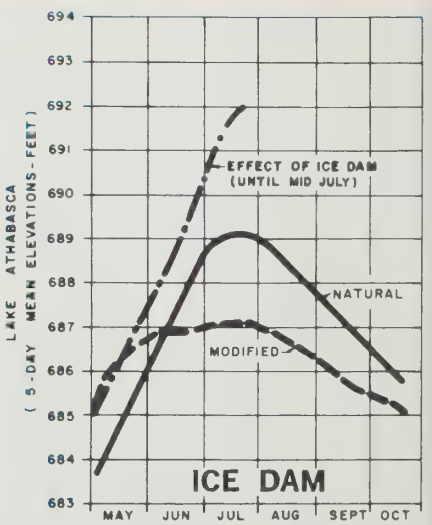


- Operation required
- Ice problem
- Cost: $5,500,000

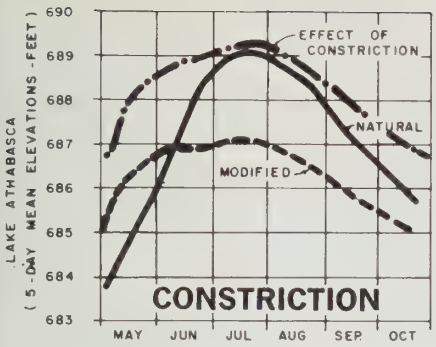
ICE DAM, RIVIERE DES ROCHERS



- Silt deposition and flushing action partially restored
- No fish ladder required
- No locks required
- Periodic installation required
- Cost: $750,000



ASSESSMENT OF ALTERNATIVES



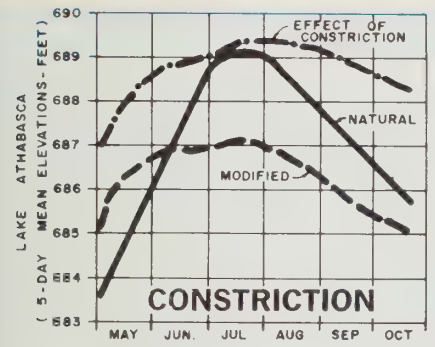
- No operation required
- Ice problem
- Cost: $13,000,000

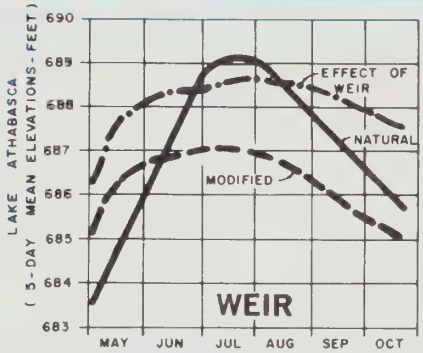
LEGEND:

Water levels in Lake Athabasca
(MEAN FOR THE PERIOD 1960-71)

- NATURAL
- MODIFIED DUE TO BENNETT DAM
- EFFECT OF PROPOSED CONTROL STRUCTURE
- LOCATION OF CONTROL STRUCTURE

Note 1. Gates always open
Note 2. Gates closed May 26 - Aug. 15



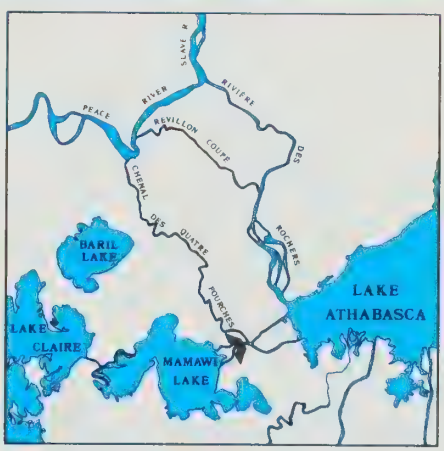


- No operation required
- Moderate ice problem
- Cost: $1,500,000

- No operation required
- Minor ice problem
- Cost: $1,000,000

TEMPORARY QUATRE FOURCHES IMPOUNDMENT

- Construction completed
  stage 1 — Dec., 1971
  stage 2 — Spring, 1972
- Cost: $200,000
- Result:
  Water levels of Lakes Mamawi and Claire rose to elevation 688.5 by June, 1972



Assessment of the sites and the structures in accordance with these factors is shown in the accompanying illustration, pages 104 and 105. The ability of the structure to restore the natural conditions is demonstrated in the graphs showing the average lake levels under the natural and modified regimes and the predicted regime with the structure in place.

The annual flushing of the Delta lakes to control salinity is an important long-term consideration. The rivers flowing into Lake Claire contain moderate to large amounts of dissolved salts, which could accumulate in the Delta lakes. Under natural conditions, flood waters from Lake Athabasca and the Peace River provided a flushing action to keep the salinity within tolerable limits for ecology of the Delta. If the flushing action is eliminated or greatly reduced, the water bodies in the Delta eventually will become saline and the shorelines and mudflats salt-encrusted. Although it is estimated that this will take a long time to occur, the quality of water in the Delta should, in the future, be monitored and periodically assessed.

The ice dam was ranked low because it would not improve the modified regime during years when it was not in place. Economically, it would not be feasible to construct it more than once in four or five years. In addition, because of the large impoundment and the severe restriction of outflow from the Lake, the ice dam could cause some undesirable downstream effects, including the lowering of Great Slave Lake and the Mackenzie River.

A control structure on the Slave River could recreate the high levels in the Peace, restoring the age-old flooding cycle in the Delta and producing conditions almost identical to nature. However, anticipated problems with navigation, fish passage and ice, combined with the relatively higher cost of either a gated or fixed control structure on the Slave, led to the selection of the Little Rapids site on the Rivière des Rochers. A structure at this site could effectively reduce outflow from Lake Athabasca and still permit navigation and fish passage via the Chenal des Quatres Fourches.

A gated structure could be operated to recreate the peak summer levels and completely restore flooding in the Delta. A fixed weir would restore average summer levels, important in

maintaining the grass meadows, but the peak flood levels would be somewhat less than would occur under natural conditions. The decrease in the flooding peaks would lead to a reduction in the upper limit or vertical range of sedge and *Calamagrostis* plant communities, possibly as much as 40 to 45 percent. In this case there would be an ingrowth of willows and a loss of some meadows until a new ecological balance is established. The degree of change which can be accepted under the National Parks Policy becomes a critical factor in assessing the relative advantages of gated and fixed weir structures.

The advantages of the fixed control structure are that it would be the least complicated, would not require continuous operation and is the most economical of the alternatives. The structure, in effect, would simply compensate for the loss of natural control due to the reduced flows in the Peace River.

Future water developments in the Basin could again alter the levels of Lake Athabasca. Because the proposed structure is relatively simple and does not require a massive commitment of public funds at this time, it offers the further advantage that it could be modified, should the need arise.

In ranking the alternatives, the fixed weir is considered to be the most viable solution. And although there would still be some loss of meadows, the weir, in practical terms, would satisfactorily meet the minimum objective of restoring water levels in Lake Athabasca and the Delta. With the weir in place, the major part of the previously existing ecological processes would be restored to approximately what would occur under natural conditions.

It is not really possible to compute the benefits in monetary terms of restoring the water levels of Lake Athabasca. As noted, a prime consideration becomes the degree of change which can be tolerated in Wood Buffalo National Park while still preserving this important example of our natural heritage for future generations. A decision to proceed will have to be based largely on a judgement of the intangible benefits which will accrue.

Effects on Channel Regime

The size and shape of the channels linking Lake Athabasca with the Peace River may have changed since 1968 when the filling of the Williston Reservoir started. Reduced peak flows

in the Peace and the corresponding decrease in sediment could lead to new patterns of channel erosion and deposition. With a structure at the Little Rapids site, some scouring and enlarging of the Chenal des Quatre Fourches can be anticipated and should be monitored. However, this should not cause any problems in controlling Lake Athabasca with a structure at the Little Rapids site.

Effects on Great Slave Lake

Future summer levels for Great Slave Lake could be as much as half a foot lower under the modified regime imposed by the Bennett Dam on the Peace River. Regulation to restore water levels of Lake Athabasca could cause a further slight drop, estimated to be in the order of two tenths of a foot in the drier years. With the restoration of water levels in Lake Athabasca the full effect of the reduced flows in the Peace River would be realized at Great Slave Lake.

Reductions in the levels of Great Slave Lake may add to the problem of maintaining barge traffic on the upper Mackenzie River, particularly on Beaver Lake which is located at the outlet of Great Slave Lake. A reconnaissance of the Great Slave Delta indicates that this area would not be seriously affected.

Extensive economic and engineering studies to assess the need and feasibility of improving barge navigation will be completed shortly. These studies will provide a basis for assessing the full impact of reduced water levels in Great Slave Lake. Further investigations to determine ways of maintaining water levels for navigation may be required. Although it is unlikely that such studies would lead to any significant changes in the recommendations to restore the water levels of Lake Athabasca, some time should be provided for such studies before proceeding with the proposed weir.

REMOVAL OF QUATRE FOURCHES DAM

The restoration of water levels in Lake Athabasca to restore ecological conditions in the Delta presupposes that there would be no restrictions to flow in the major connecting channels in the Delta. The Quatre Fourches Dam would restrict the exchange of water between the Delta Lakes and Lake Athabasca. It therefore should be removed after the proposed structure at the Little Rapids site has successfully restored the water levels.

OTHER REMEDIAL MEASURES

In addition to action to restore the water level of Lake Athabasca, the study has identified supplementary measures which could be taken to assist in developing and maintaining viable trapping and fishing industries.

Small dams could be constructed to manage specific areas, particularly in the Chipewyan Indian Reserve and the Alberta portion of the Delta, for muskrat production. A muskrat farming approach could greatly increase the rewards of trapping and provide valid support for the Fort Chipewyan economy.

In light of the importance of the walleye to the local fishing industry, works may be required to ensure that the migration into Richardson Lake for spawning is not restricted by channel ice. Walleye spawning runs should be monitored to determine whether additional action is required.

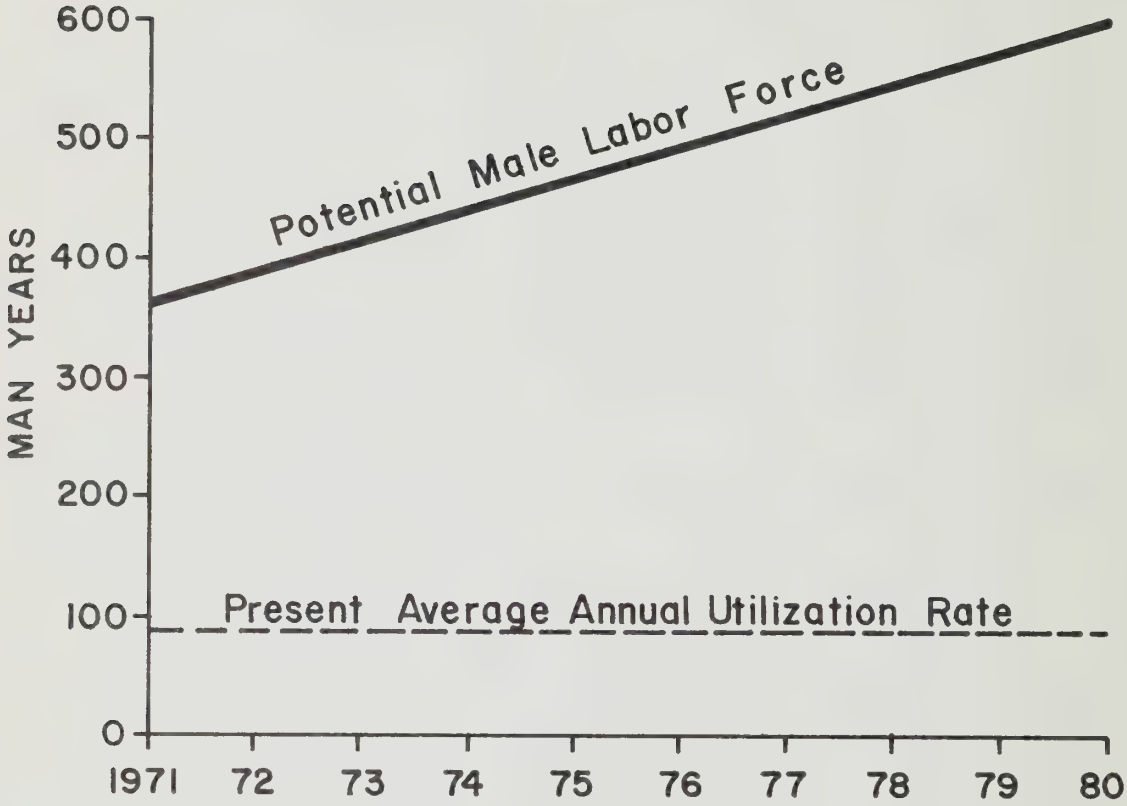
ALTERNATIVE EMPLOYMENT POSSIBILITIES

The restoration of water levels in the Delta will eventually restore to historical levels the production of muskrat and fish, improving present trapping and fishing opportunities, but this cannot be expected to provide a cure-all for the critical unemployment situation in Fort Chipewyan. As explained in chapter three, this is a deep-seated problem that will continue to escalate without some very imaginative action to utilize every possibility for producing jobs in the area.

If the utilization of the labor force continues at its present rate, which is only 88 out of about 380 man-years available, the situation for the people could be grave indeed. The projected labor force will increase to over 450 man-years by 1980, greatly intensifying the problem.

The Project has identified a range of potential projects that could increase the utilization of the labor force quite significantly. Among these are proposals for a granite quarry at Devil's Gate on the Rochers, a smoked-goldeye cottage-type operation, a fish processing and freezing plant, an enterprise to process smoked or dried buffalo meat, home construction projects utilizing local logs, and perhaps an extension of the water and sewer system to the entire community. It is essential that the younger people find challenging and interesting job opportunities in which they can employ the skills they have learned or in which they could broaden their horizons by learning new skills. Given an opportunity, these younger people could conceivably contribute substantially to plans for new and more imaginative employ-

FORT CHIPEWYAN POTENTIAL LABOR FORCE AND UTILIZATION, 1971-80



ment programs and could be motivated to take on new responsibilities and build new projects into viable commercial or industrial enterprises. It is urgent that further assessment be undertaken of the projects suggested and of any other opportunities to provide jobs. It is essential that discussion be pursued with local people, that the younger generation be included in the planning processes, and that every effort be made to discover means of utilizing the local resources and skills in Fort Chipewyan.



the legal framework

seven

LEGAL AND JURISDICTIONAL CONCERNS

A major aspect of the study has been a probe into the management and use of the waters of the Peace River in the special context of the relationship of this river to the entire water and ecological regime of the Peace-Athabasca Delta.

Rising in British Columbia, the waters of the Peace flow through Alberta to join the Slave River and on northward to the Northwest Territories. As we have seen, the levels of the Peace River waters are the major determinant in the levels of Lake Athabasca, which lies partly in Alberta and partly in Saskatchewan. And upon the levels of Lake Athabasca depends the whole hydrological and ecological scheme of the Delta. The question of management and use of these Peace waters manifestly transcends the strictures of provincial borders and the special interests of any one province. It is a vital concern of the provinces of British Columbia, Alberta and Saskatchewan and of the government of Canada. Use of Peace River waters by one has relevance for all.

The historical economic value of the Peace River has been as an artery for navigation and transportation, as a fishery, as a source of domestic and industrial water supply and of potential for electric power. But it has also played a vital role in sustaining the ecological regime in the Peace-Athabasca Delta, the significance of which has been abundantly established.

Depending upon which of these uses may be made of the waters of the Peace, they are subject to sundry provincial or federal laws under the provisions of the Canadian constitution. In their uses for navigation and transportation, in the regulation of fisheries, in their effects upon Wood Buffalo National Park or upon migratory birds, these waters are clearly in the jurisdiction of the Parliament of Canada. But in their use for domestic or industrial water supply or for the generation of electric power, the Peace waters are subject to the legislation of the province where such use is made. Such varying uses to which the same water may be put, together with the division of lawmaking authority between provincial and federal jurisdiction relating to that water, creates a most complex legal framework within which conflict of interests must be judged.

THE ISSUES

The constitutional and legal issues raised by the Peace-Athabasca Delta problem present a vivid example of the difficulties under which water management in Canada must be conducted. The necessity was not foreseen by the framers of the B.N.A. Act of granting to either federal or provincial governments the power to make specific laws regarding either water or environmental management, as such.

Laws have been passed, however, by provincial and federal governments relating to different aspects of water control and the uses to which water may be put. With both the provinces of British Columbia and Alberta claiming ownership of the waters of the Peace River within their territores, and the federal government asserting the same rights of ownership of Peace waters in Wood Buffalo National Park and in the Northwest Territories, the situation becomes quite bewildering. Both the federal and provincial governments may have rights of ownership in the same water, and all three governments, under the constitution, may exercise their power to pass laws over the same body of water at the same time and in the same location.

COMMON-LAW CONCEPTS

The basis of water law in Canada has been the common law of England, modified from time to time under the provisions of the B.N.A. Act by enactments of the federal government and the provincial governments. It has long been the concept of common law that water flowing in a defined channel cannot be owned by any one person, but that persons owning land adjoining such water may claim the right to its use and enjoyment.

From this right developed the doctrine of riparian rights (from the Latin word *'ripa'* meaning bank) of reasonable use of the water by the owner of the bank of a stream, river or lake. These riparian rights included the right of access to the water, the right of drainage, rights relating to the quality and quantity of the water, and rights relating to the use of the water, and the right of accretion. These rights of the riparian were subject to the rights of other riparians in the same water. The upstream riparian's reasonable use of the water could not be to the detriment of the downstream riparian's use of the same water.

Common law has also recognized public rights to navigation and fishing, but these rights have been modified by Canadian courts. In the western provinces the public holds the right to

KEY LEGISLATION

THE INTERNATIONAL RIVERS

ACTS PERTAINING TO WATER

The British North America Act

CANADA

THE FISHERIES ACT

CANADA

THE NAVIGABLE WATERS PROTECTION ACT

CANADA

The National Parks Act

CANADA

The Migratory Birds Convention Act

CANADA

NORTHERN INLAND WATERS ACT

The British Columbia Water Act

THE ALBERTA WATER RESOURCES ACT

The Saskatchewan Water Rights Act

CANADA

THE CANADA WATER ACT

navigation in navigable waters in such a manner as not to interfere with the similar rights of others. Only the federal government may pass laws with respect to navigation, and many such provisions have been made. Public righs to fishing, however, have not been clarified in Canadian courts.

DEVELOPMENT OF WATER LAWS IN THE WESTERN PROVINCES

Prior to the establishment of local legislatures in the Canadian west and northwest, the English common law and statutory law prevailed. With the establishment of a local legislature, power to enact local laws resided with this legislature. So it is that the Provinces of British Columbia, Alberta and Saskatchewan all have the heritage of the common law, as modified by local courts and legislatures, regarding the rights inherent in, and the use and enjoyment of water within their borders.

The British North America Act of 1867 divided legislative jurisdiction between federal and provincial governments. When the western provinces entered confederation, their existing water laws were continued, subject to modification by laws passed by the legislature having the authority to act. Since the western provinces were granted ownership of land and natural resources within their boundaries by the constitution, and since they also had the authority to pass laws in relation to "property and civil rights in the province", they asserted ownership in the water flowing over the provincial land. The federal government, holding ownership of certain specific properties in the western provinces, used similar legislative authority to assert the same rights of ownership to water flowing over its property.

The existing confusion and complexity with regard to water law, then, arises out of rights of ownership in water bodies enjoyed by both federal and provincial governments and the ability of each to pass laws in different areas with regard to a body of water which may affect the water rights of other governments in that same water. The Government of Canada and the governments of the western provinces, clearly acting within their constitutional rights, have passed laws which have altered the pre-existing common law doctrines applicable to the use and enjoyment of water.

The British Columbia Water Act appears to repeal the common law with respect to water. All ownership in, and the right to the use of all waters in the province belong to the Crown in the right of the province.

The Alberta Water Resources Act, less sweeping in its provisions, places ownership in any water in the province over which the province has legislative authority, in the Crown in right of the province. However, with the exception of the diversion of water, which is prohibited unless a license has been issued under the Act, the rights of the riparian owners appear to be unaffected.

The Saskatchewan Water Rights Act also gives ownership of all surface and ground water in the province to the Crown in the right of the province, abrogating only the common law right to impound or divert water. All other riparian rights have been preserved.

WATER LAW AND THE DELTA PROBLEM

Under the Northern Inland Waters Act, the federal government has vested in the Crown, in the right of Canada, the ownership of, and the right to the use and flow of all waters in the territories over which it has exclusive ownership and legislative jurisdiction. A similar provision in the National Parks Act grants the same rights to the federal government with respect to the waters within Wood Buffalo National Park.

It is within this context that the legal and jurisdictional issues associated with the Peace-Athabasca Delta must be viewed. Assuming that a relationship exists between the regulation of the waters of the Peace River in the Province of British Columbia and the downstream effects in the Province of Alberta and the Wood Buffalo National Park, what is the legal situation?

First, constitutionally, the basis upon which a province may claim exclusive regulatory rights in regard to water management is the authority it holds in relation to "property and civil rights in the province" and "matters of a local and private nature in the province". An additional source of legislative authority may be found in relation to "local works and undertakings".

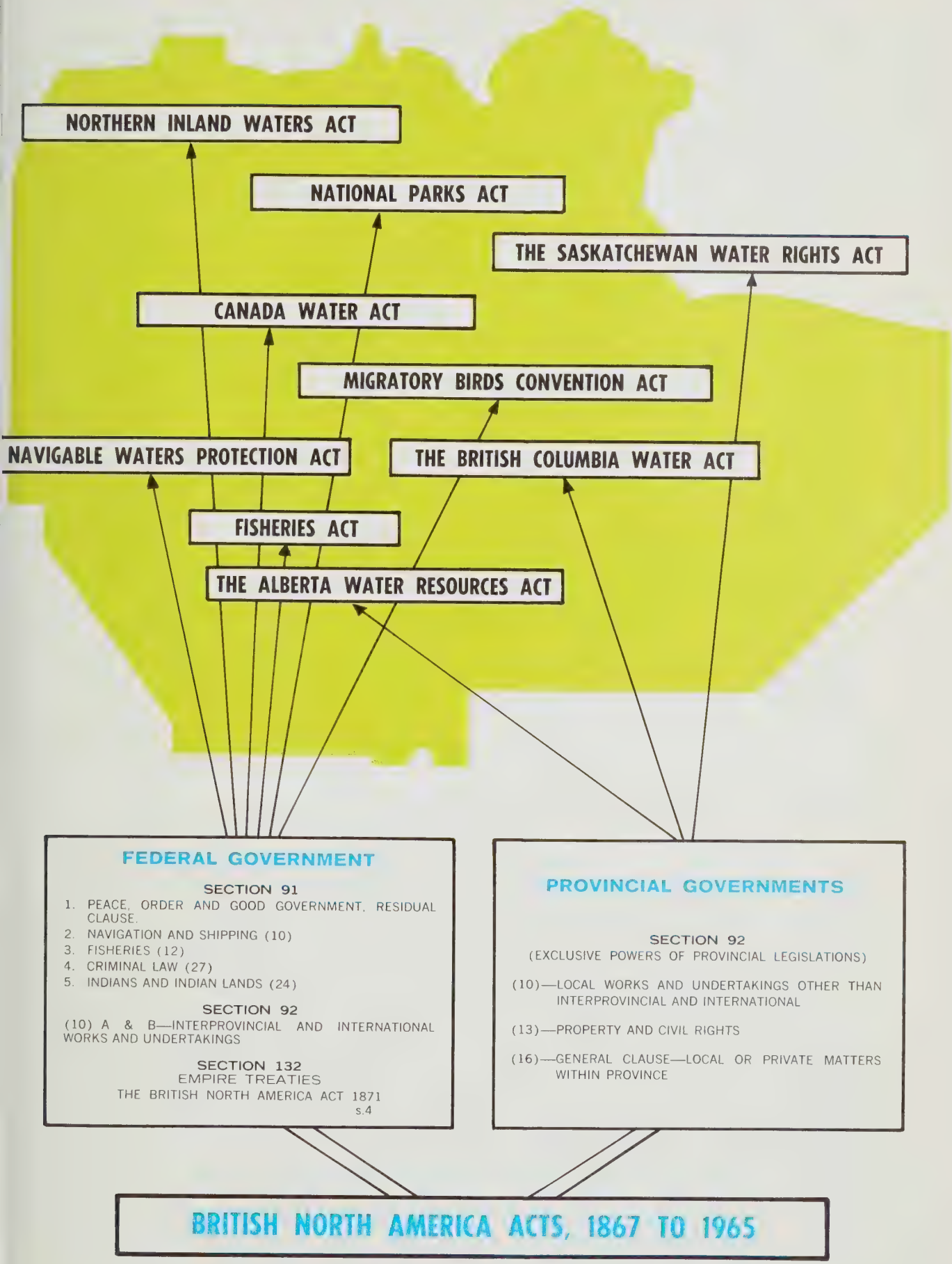
Second, as has been indicated, the generation of hydroelectric power and its use within a province is a matter within the scope of the legislative jurisdiction of the province.

Third, as far as British Columbia is concerned, its relevant statutes appear to have abolished all pre-existing riparian rights under the common law doctrine. Certainly, it is clear that a riparian owner's right to use water has been restricted to the extent that his right may not interfere with the rights of a provincially licensed appropriator of water.

On the basis of these points, it may be said that the regulation of the flow of the Peace River within British Columbia, for

KEY LEGISLATION RELATING TO WATER MANAGEMENT

PEACE-ATHABASCA DELTA



the purposes of providing water for the Gordon M. Shrum Generating Station, was within the legislative jurisdiction of the Province of British Columbia. Further, it appears that the planning, construction and operation of the project was carried out in accordance with all the requirements of the law of the Province of British Columbia.

On the other hand, since legal precedence indicates that the Peace River is a navigable stream, the provisions of the Navigable Waters Protection Act apply to this river. Therefore, approval was required by the Federal Minister of Public Works before a work such as the W. A. C. Bennett Dam could be constructed on the Peace River. Neither the British Columbia Hydro and Power Co. nor its predecessors did, in fact, obtain such approval. Similarly, there is uncertainty as to what extent the requirements of the Fisheries Act of Canada were met by the developers of the W. A. C. Bennett Dam.

However, other questions arise which are not quite so susceptible to definitive answers. The Peace River Power Project was located on an inter-provincial and apparently navigable river and obviously must affect rights outside the Province of British Columbia. It is apparent that the Peace River is an integral part of the hydrological system in the Provinces of Alberta, Saskatchewan and of the Northwest Territories. In addition, the Peace River flows through Wood Buffalo National Park, which is not only owned by, but is also under the exclusive legislative jurisdiction of the federal government, with respect to water resources.

THE CRUX OF THE PROBLEM

The problem therefore is real and concrete; can a Province, i.e. British Columbia, though acting in accordance with laws which it has passed, unilaterally authorize the impoundment of water within its territorial limits so as to affect the flow and quantity of water in another province? Can British Columbia, legislating pursuant to its jurisdiction over "property and civil rights" and "matters of a local and private nature" within British Columbia, so act as to curtail those same rights in adjoining provinces? To these questions must be added another: can a province so curtail the flow of water so as to affect conditions beyond its own boundaries?

Unfortunately, there is no clear legal answer to any of these questions. Such situations have not come before Canadian courts, and constitutional documents appear to be silent on these mat-

ters. There have been cases where provincial legislation was held to be invalid, as attempting to curtail rights outside of the province. Thus it may be argued that this would apply to legislation of one province which would have the effect of depriving a person in a neighboring province (or the province itself) of his riparian interests. In the situation under study, the effects upon riparian rights outside the Province of British Columbia have not been minor, and this might be a factor in a court's determination of a case based on this principle.

An intending litigant, basing his claims upon the adverse effects of the regulation of the Peace River by the Province of British Columbia upon his property, will be faced with two quite simple but fundamental questions. The first: in the courts of which Province should he bring his law suit? The second: which law would that court apply in a determination of his action? The answers to both, at this time, are uncertain, and yet such answers may be crucial to the success or failure of his action. There is authority which indicates that the action could be brought in a court of the province in which his land is situated, and some authority that it may be in that province where the apparent cause of the damage is located. As to the law which might be applicable, some writers even think that a court competent to entertain such an action would decide it on the basis of the common law principles of riparian right.

In an action between two provinces, or between a province and the federal government, the likely court would be the Federal Court of Canada. As to which law the Federal Court of Canada would apply, there is no guaranteed answer.

The complexity and confusion of the present jurisdictional and legal framework for water management in Canada is now apparent. That such is the case is perhaps understandable in the light of our legal development, but the possibility that such confusion should continue, is not. The Peace River Power Project was conceived in the late fifties and executed in the sixties. The concerns of the seventies, unfortunately, were not within its purview. Water was then seen, apparently, only in terms of its economic value as a source of electric power. It was not seen as the very artery of life to an amazingly complex ecological system outside of the Province of British Columbia.

What of the future? If law is dynamic and is capable of moulding itself to meet new situations, what lessons are to be learned from the studies of the Peace-Athabasca Delta?

First, that in a federal state, such as Canada, any action on an inter-provincial water resource by a particular province must

be done on the basis of the consent, at least, of those other jurisdictions involved.

Second, that such arrangements, which would form the basis of interprovincial co-operation in the planning and management of interprovincial water resources, should perhaps be based on the river basin forming the management area.

Third, that water, and developments of any nature thereupon, can no longer be viewed in splendid isolation from its inter-relationship with other aspects of environmental management.

Fourth, that the major legislative devices presently open to the federal government with regard to navigation, shipping, fisheries, migratory birds, and the national parks, are ineffective tools for the protection of anything other than these specified federal interests.

Fifth, the federal government, whose responsibility extends to matters outside of provincial boundaries, should enact laws which would create a framework in which total environmental management and protection would take place. The Canada Water Act, which provides for joint federal-provincial planning and implementation, is a first step in this direction, but is limited primarily to water matters.

Sixth, that such a federal legislative framework should permit those matters which are local to be dealt with locally, those which are regional to be dealt wih regionally, and those which are national to be dealt with nationally. In other words, it should allow for the fullest co-operation of the provinces, either singly or severally.

And finally, regardless of which arrangement for environment management is devised, provision must be made for governmental reviews, including public participation in the conception and planning for major works such as reservoirs and diversions in both pre-formal and formal stages.


government
co-ordination

eight

Canada, Alberta and Saskatchewan share the responsibilities for the management of Lake Athabasca and the Peace-Athabasca Delta. As noted earlier, a highly complex environment has evolved from the dependence of plant and animal life on levels of water in Lake Athabasca, and the subsequent dependence in part, of the local people, on fishing and trapping in the area. The roles then, of the various governments in the management of such an environment, and the mechanisms for co-ordination, are of vital concern. This is particularly true at the present time when governments are called upon to deal with the current problem of low water levels.

The Co-ordination Problem

Today, some 30 federal and provincial agencies are involved with the various programs in the area. Locally, there is no organized municipal government. The department of Municipal Affairs of Alberta established a local advisory committee several years ago, but it has not, up to now, functioned very strongly. The local people, while they co-operate in general, tend to maintain their tribal bonds rather than identify with the total community.

These people find the great array of government agencies confusing and overwhelming. At the same time, most feel that they do not have an adequate voice in many of the government decisions which affect their way of life. Observations have been made that there are overlaps in the activities of various government agencies, and that there is a need for improved communication and co-ordination in the delivery of programs.

For instance, the collecting and processing of data on trapping and fishing is conducted by several agencies and needs to be more fully co-ordinated. This will be particularly true if these activities are to be developed into viable northern industries.

The proposal to construct a control dam on the Lake Athabasca outflow system carries with it a new set of responsibilities for the governments. Additional monitoring will be required to assess the effects of the dam on erosion, sedimentation and water quality in the Delta. There is also the question of liability,

should undesirable water levels occur following completion of the remedial works. The public might well view the remedial dam as an indication of a more active role on the part of governments. Accordingly, they would look for more active and continuing discussion of water management problems in Lake Athabasca.

The need for increased local involvement has also been identified. As noted, many of the local people find the "bigness" of government overwhelming. Real communication gaps do exist between the local people and government.

The experience of the Peace-Athabasca Delta Project has shown that this can be bridged by having the people participate in the formulation of programs, and giving them responsibilities in carrying them out. In this way they can make valuable contributions by providing local data, experience and ideas. Most important, participation generates a commitment.

There are certainly a number of management considerations unique to the Lake Athabasca region, particularly in the Peace-Athabasca Delta sector. Only a further integration of governmental approaches in a number of areas, such as data collection and water control, can resolve the attendant problems. If the social development of the area is to proceed in any orderly manner, it is essential there be much closer co-ordination in many local and regional matters among the many federal and provincial agencies operating there. Efficient overall planning could activate real progress in the development of the area and so help to place the problems of water and related resource management in the proper perspective.

All these factors support the need for the establishment of an inter-governmental vehicle to co-ordinate federal and provincial activities involved in the regulation of Lake Athabasca and the management of Delta resources. Local participation should be provided for in defining the responsibilities of the co-ordinating group.

Alternative Approaches

Such a vehicle could take several forms, varying from an ad hoc committee to a formal intergovernmental board. In the case of a formal board, its areas of responsibilities would be set out in an agreement which would define how the board would be appointed, structured and funded. The need for such a for-

mal arrangement has to be assessed in the light of the decisions which would come before the board, and whether such decisions would be required on a continuous basis.

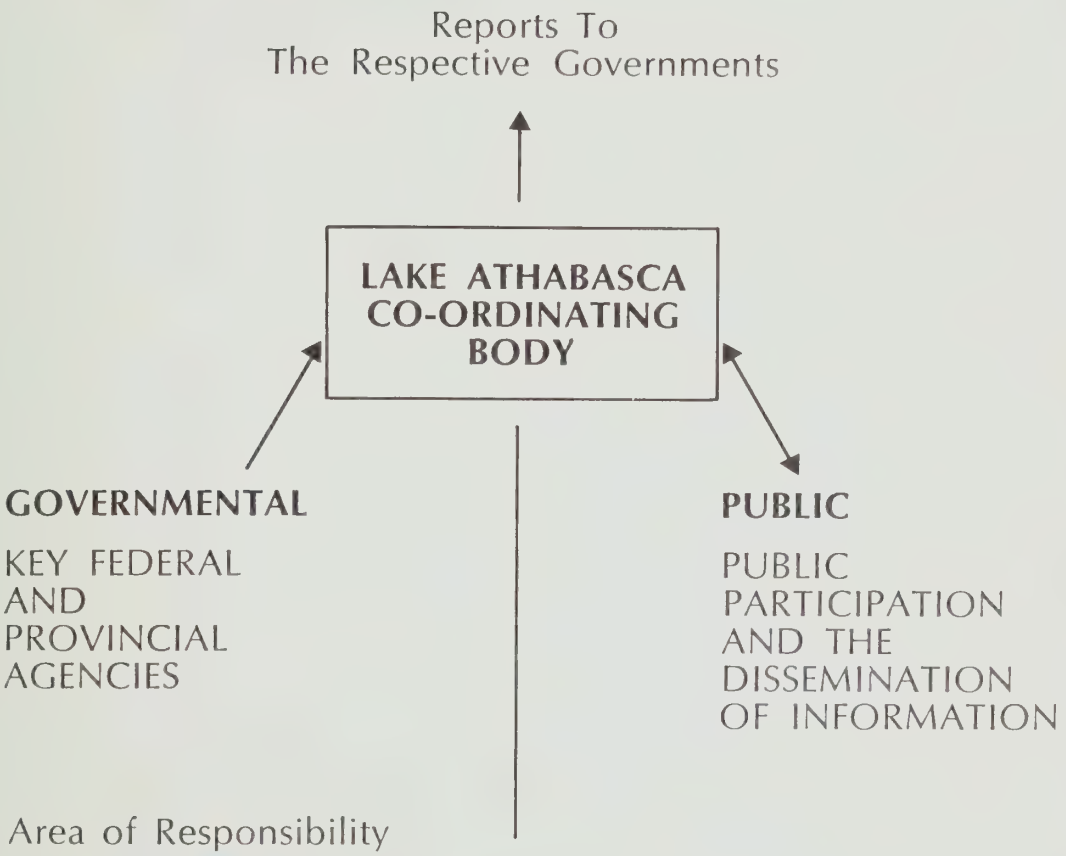
It is anticipated that most of the matters which would come before an intergovernmental group would deal with the co-ordination of resource-monitoring programs and with the concerns and problems of the local people, arising out of the changes in water levels. These matters could be handled conveniently by a senior intergovernmental group. Thus it is recommended that the participating governments establish such a body. The concept, in terms of responsibilities and functions, is outlined in the chart on the next page.

As noted, the area of responsibility of the co-ordinating vehicle will be that of water and related resources, and therefore could be limited. However, the very fact that a mechanism is functioning for intergovernmental communication, specific to a particular geographic area, should foster increased co-operation in other areas.

This organization could also provide continuity between the Peace-Athabasca Delta Project and the implementation of recommendations flowing from it.



PROPOSED INTERGOVERNMENTAL CO-ORDINATING GROUP



Area of Responsibility

- Water and related resources Lake Athabasca Region

Key Functions

- To provide co-ordination for related federal and provincial resource programs
- To arrange for public participation and the dissemination of public information
- To advise the respective governments on needs and priorities

L. ALLISON PHOTO





the peace-athabasca delta project

nine

It was in response to growing public concern about the Peace-Athabasca Delta that the government ministers responsible for environmental matters for Canada, Alberta and Saskatchewan agreed, in December 1970, to the intergovernmental investigation. Because of the urgency with which both scientists and the public viewed the problem of low water levels in the Delta, the governments directed that the preliminary assessment be completed by the fall of 1971. A final report outlining the long-term solutions was scheduled for 1972.

Project Organization

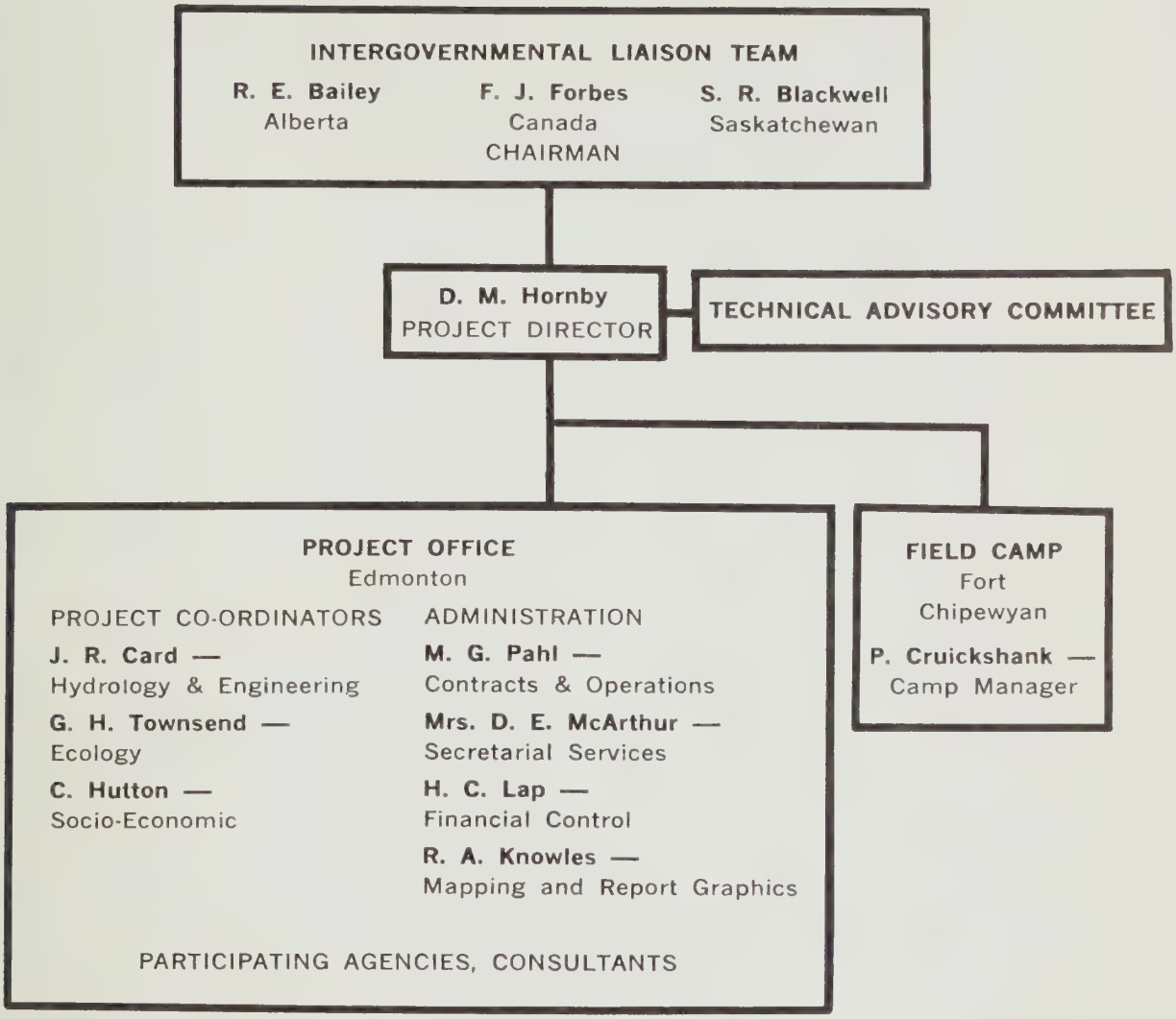
The project was structured to ensure that the investigations would be intergovernmental and interdisciplinary in scope. Major study components were assigned to agencies of the participating governments. The organization of the project is shown in the accompanying chart.

The Intergovernmental Liaison Team represented the participating governments on policy matters and provided executive direction for the project. The Technical Advisory Committee, consisting of senior management and scientific experts drawn from the federal and provincial departments, provided advice and direction on the technical and resource management questions arising out of the investigations. The Project Office directed the co-ordination and integration of the studies, employing consultants extensively to augment government forces.

Canada agreed to bear the major cost of the project. The Alberta Government provided staff and services, in particular to undertake the hydrological investigations. Saskatchewan assisted by loaning technical staff for fishery and recreation studies on Lake Athabasca. British Columbia declined to participate in view of pending legal action arising out of the reduced flows on the Peace River, but made technical data available.

Project offices were opened in Edmonton on January 15, 1971, and a field camp was established in Fort Chipewyan in March. Some 30 federal and provincial agencies, plus a large number of non-governmental agencies and individuals participated in the project at different stages of the investigation.

ORGANIZATION: PEACE-ATHABASCA-DELTA PROJECT



MEMBERS — TECHNICAL ADVISORY COMMITTEE

G. J. Bowen, Canada Department of Indian Affairs & Northern Development, Ottawa
G. E. Couldwell, Saskatchewan Department of Natural Resources, Regina
A. Coulson, Environment Canada, Ottawa
L. J. Cowley, Environment Canada, Winnipeg
C. D. Forbes, Canada Department of Public Works, Edmonton
E. C. Holmes, Canada Department of Indian Affairs & Northern Development, Edmonton
W. J. Hughes, Canada Department of Indian Affairs & Northern Development, Saskatoon
C. J. R. Laurie, Ministry of Transport, Ottawa
W. G. Leitch, Ducks Unlimited (Canada), Winnipeg
D. L. MacLeod, Saskatchewan Department of the Environment, Regina
Dr. A. Macpherson, Environment Canada, Edmonton
M. J. Paetz, Alberta Department of Lands & Forests, Edmonton
R. J. Paterson, Environment Canada, Winnipeg
S. W. Reeder, Environment Canada, Calgary
V. P. Rolfson, Canada Department of Indian Affairs & Northern Development, Calgary
J. K. Rose, Ministry of Transport, Hay River, N.W.T.
R. H. Smith, Ministry of Transport, Ottawa
G. Staines, Environment Canada, Edmonton

THE STUDY APPROACH

The study moved rapidly to assess the extent of the ecological changes before entering the mainstream of the detailed hydrological study. The first stage, completed in September of 1971, led to the construction of the Quatre Fourches Dam. The second stage, commenced in October of 1971, concentrated on finding a long-term solution to the problem of low water levels.

STUDY OBJECTIVES

The study objectives can be summarized as follows:

- To determine the water management requirements for the conservation of the Delta and its muskrat, migratory birds, fish and other wildlife.
- To determine the required water level regime for Lake Athabasca, taking into consideration ecology requirements of the Delta, navigation, and possible downstream effects.
- To determine the needs of local people in relation to water and related resources of the Delta and Lake Athabasca.
- To determine, if required, the nature and feasibility of control works necessary to regulate Lake Athabasca.
- To determine the need and feasibility of an intergovernmental vehicle to improve governmental co-ordination and to provide for public participation.
- To identify areas where additional resource monitoring and investigations might be required.

MAJOR RESPONSIBILITIES

The major responsibilities for study were assigned as follows:

1. Hydrology	Alberta Water Resources Division with assistance from the Water Survey of Canada
2. Ecology	Canadian Wildlife Service
3. Surveys and Engineering	Peace-Athabasca Delta Project Office
4. Socio-Economic	Peace-Athabasca Delta Project Office
5. Support Services	Peace-Athabasca Delta Project Office

The Water Management Service, Environment Canada, provided the intergovernmental coordination and funding.

In the course of the investigations some sixty reports were prepared by wildlife biologists, hydrologists, economists, historians and members of disciplines involved in the investigations. The information from those reports is now being integrated into a technical report on the Project and an information index of the reports and other data prepared by the Project will be available to the offices of the participating agencies.

LOCAL INVOLVEMENT

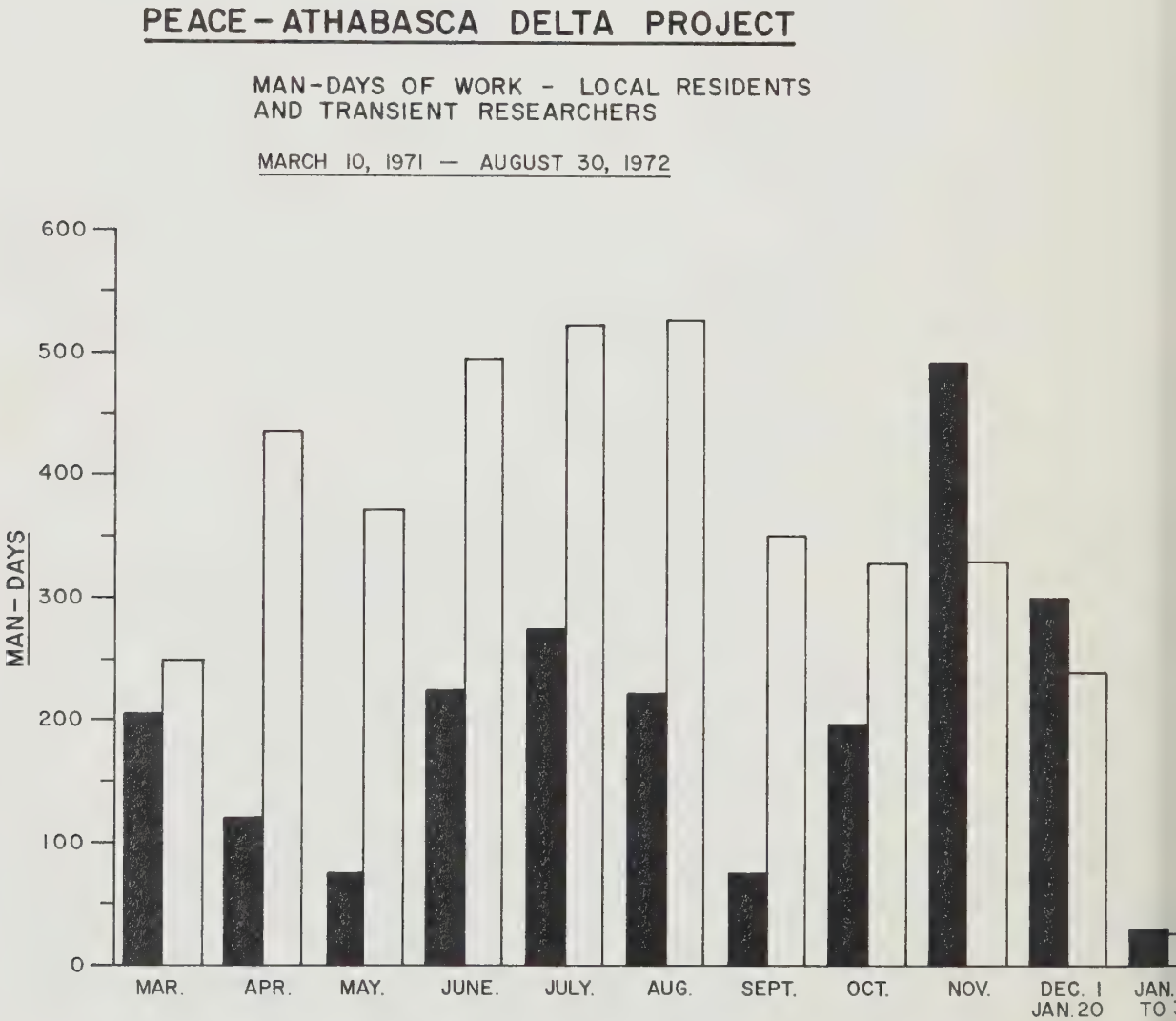
Throughout its field surveys, a prime aim of the Project was to employ local people whenever possible. In this way, the Project provided a number of jobs for the people of Fort Chipewyan, giving the community a much-needed boost. Many of the individuals received good training and experience in the use of survey techniques and equipment. Those employed showed that they were quite capable of learning new techniques and assuming responsibilities on technical surveys.

The accompanying chart on pages 132 and 133 illustrates the extent of the use of local people in the field work. It is interesting to note the increase in the proportion of local workers as these people became familiar with the work and trained fellow-residents to assist them.

During the summer of 1971 the Project provided such support as communication, transportation and camp facilities for an "Opportunities for Youth Project" under the federal program. Twenty-four students, including 11 from Fort Chipewyan participated in hydrological and ecological surveys.

CONSTRUCTION

Two projects, The Quatre Fourches Dam and the Athabasca Diversion Control Project, constructed as a part of the Delta Project, have been described in Chapter 6. These projects demonstrated the capacity of governments to co-operate and respond quickly to an urgent situation. Design for the Quatre Fourches Dam was provided by the Alberta Water Resources Division, while the National and Historic Parks Branch of the federal government handled the construction. This $200,000

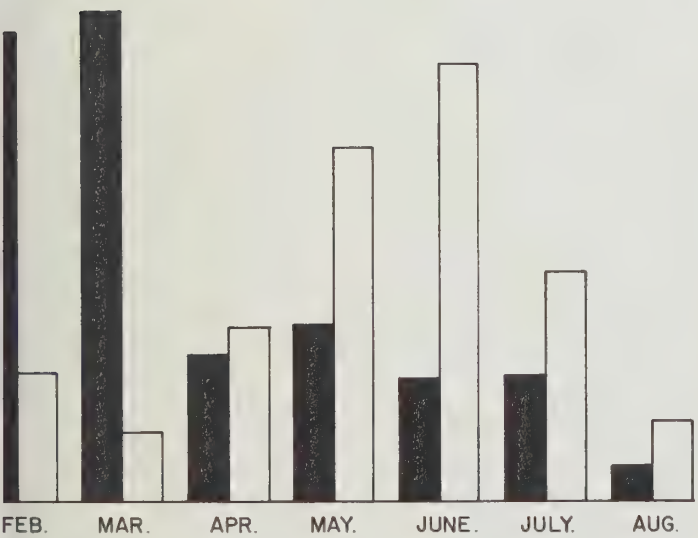


project was authorized in September 1971, and was completed by December 1. In the case of the Athabasca River Diversion Project, the Alberta Water Resources Division carried out the design and construction, with Canada contributing 75% of the $155,000 construction cost. The Delta Project provided co-ordination and support in the form of transportation, living quarters and other facilities for both projects.







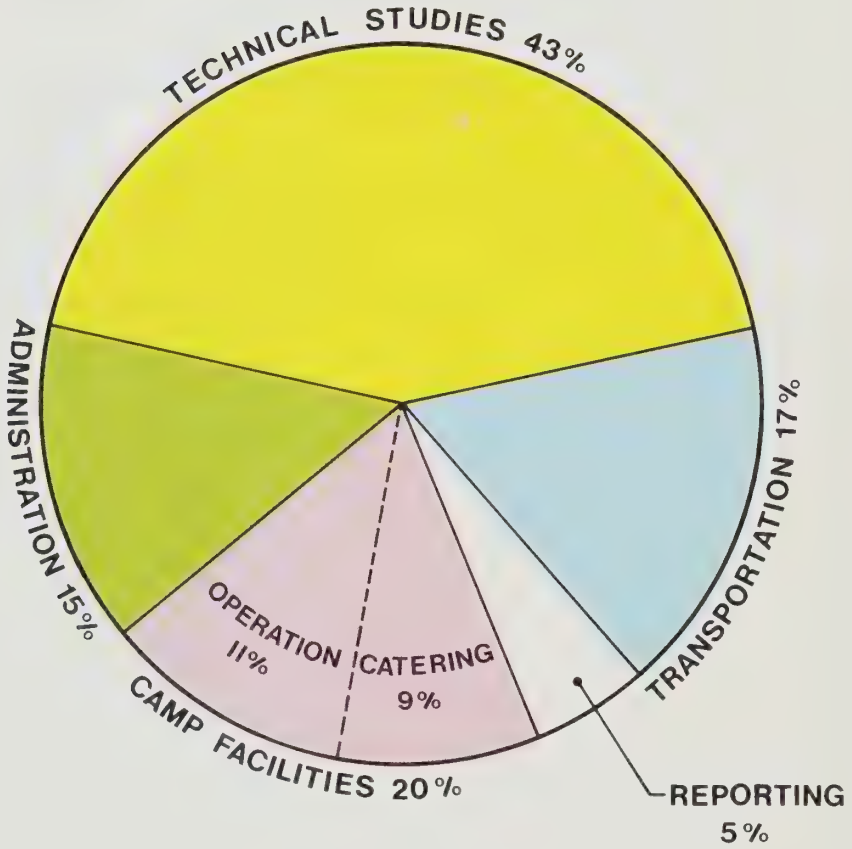


PROJECT COSTS

The direct costs for the Project were:

1. The Study		$1,350,000
2. Research, Ice Dam		32,000
3. Construction		200,000
	Total	$1,582,000

The breakdown of the costs for the study is shown below.



The total cost for the 20-month period of the Project's operation was approximately $1,500,000. Considering that the area of the Delta is roughly one and one-half million acres and that the focus of the Project was on this area, the cost to the Canadian taxpayer was about $1 per acre.

THE LESSONS LEARNED

The Peace-Athabasca Delta Project Group has dealt with an extremely complicated environmental problem. Its complexity arises from the physical nature of Lake Athabasca and the Delta, in conjunction with the involved legal and management setting. In the course of the study, a number of important lessons have been learned:

1. Solution to such complex environmental problems requires an approach which provides for a full assessment of all interdisciplinary and intergovernmental aspects. The complex relationship between the water levels of Lake Athabasca and the Delta ecology clearly indicates the importance of an interdisciplinary approach. Similarly, the number of jurisdictions and agencies involved in the management of the various resources, such as migratory birds and fish, illustrates the need for the intergovernmental approach.

2. Experience on the Delta Project indicates that three organizational requirements are essential if an intergovernmental group is to function successfully.

   (i) The executive group appointed by the governments must take an active role in providing overall direction and policy. Within this framework, if there is urgency, the project must be given a high degree of autonomy and the project director a high level of authority, reasonably divorced from the restrictions of various regulations of the participating governments. This applies particularly to governmental restrictions on man-year allotments.

   (ii) A project group consisting of the various technical specialists must be brought together. It must be strong enough to carry the thrust of the investigations and to provide the co-ordination necessary to integrate the study.

   (iii) People assigned to the project group should be freed from their departmental responsibilities and located in the same office. In the case of the Delta Project, this group consisted of eight people.

3. Additional demands were placed upon the time and abilities of the people working on the Delta Project, and in all likelihood this will hold true in the work of similar project groups. Competent people assigned to such groups gain extensive experience that increases their value to their respective agencies. An appropriate method should be developed to compensate the participants for the increased demands placed on them.

4. The use of consultants and non-governmental agencies can provide new approaches and inputs into the assessment of complex environmental problems. This manner of operation should be encouraged.

These conclusions, drawn from the experiences of the Peace-Athabasca Delta Project, will provide valid guidelines for further task-force investigations into matters that involve a number of different governments or governmental authorities and a wide spectrum of subject material to be examined.

This cairn at Fort Chipewyan commemorates Fort Chipewyan's historic significance as an early fur-trading post, as the starting point of Alexander Mackenzie's expeditions to the Arctic and the Pacific Oceans, and as a major camp in Franklin's first arctic explorations.





recommendations

ten

The results of the surveys and investigations summarized in this report indicate the need for positive action by the Governments concerned. To the members of the Project group, the following recommendations flow logically from the evidence compiled.

THEREFORE IT IS RECOMMENDED:



THAT GOVERNMENTS ASSIGN A HIGH PRIORITY TO THE CONSERVATION OF THE PEACE-ATHABASCA DELTA.

The Peace-Athabasca Delta is truly an irreplaceable international, national and provincial resource. Lake Athabasca, one of Canada's largest northern Lakes, is equally important. Internationally, the Delta is a key link in the North American Flyways for waterfowl; nationally, this is the only delta within the Canadian Park System; provincially, both the Delta and Lake Athabasca contribute to the well-being and life style of the local people and to the regional economy. A permanent shift in the ecology of the Delta towards the less productive shrubs and forest will result in a serious loss of its rich and productive wetlands.

This loss can and should be avoided. To do so, governments should assign a high priority to programs for the restoration of water levels in Lake Athabasca and of the natural environment of the Peace-Athabasca Delta, and to continuing programs required to effectively monitor and conserve these important natural resources.



THAT THE GOVERNMENTS OF CANADA, ALBERTA, AND SASKATCHEWAN, BY AGREEMENT, IMMEDIATELY ESTABLISH A SENIOR INTERGOVERNMENTAL COMMITTEE TO PROVIDE THE LIAISON AND CO-ORDINATION FOR THE RESTORATION OF WATER LEVELS AND RELATED MATTERS IN THE LAKE ATHABASCA AND THE DELTA AREA

Critical to any proposed solution are the political and management aspects which arise out of the geographic setting of Lake Athabasca and the Delta. Canada, Alberta and Saskatchewan share the jurisdictional responsibilities for water and resource management in the area. The hydrologic, deltaic and ecological systems are complex and interrelated. Therefore, the major part of planning and action in the area, to be fully effective, must be interdisciplinary and intergovernmental. The proposal to restore the water levels of Lake Athabasca carries with it a new set of responsibilities for the governments. Because of this, it is deemed advisable that the terms and conditions for the restoration of water levels be outlined in an intergovernmental agreement.

Establishment of an intergovernmental committee will help to improve co-ordination among some thirty federal and provincial agencies involved in the region. Equally important, it will provide a vehicle for implementing the recommendations adopted by the governments and provide continuity between the study and action phases of the Delta Project.

THAT A SUBMERGED WEIR CONTROL STRUCTURE BE CONSTRUCTED AT THE LITTLE RAPIDS SITE AT THE RIVIERE DES ROCHERS TO RESTORE LAKE LEVELS ON LAKE ATHABASCA, AND CONSEQUENTLY ON THE DELTA, TO APPROXIMATE WHAT WOULD HAVE OCCURRED UNDER HISTORICAL CONDITIONS.

The Bennett Dam has greatly modified the flow in the Peace River. The natural control of the outflow from Lake Athabasca, created by the flood flows in the Peace River, has been greatly reduced. Man-made controls are now necessary to offset the effects of the modified flows in the Peace River and to restore water levels in Lake Athabasca.

Preservation of the vast sedge and *Calamagrostis* meadows, the perched basins and other wildlife habitat created by the average summer water levels and the flood levels which occurred previously to 1968 is manifestly necessary. If remedial action is not taken, ecological succession will continue and cause a permanent shift towards the less productive plant communities of shrubs and forest.

THAT THE TEMPORARY ROCKFILL DAM ON THE WEST ARM OF THE QUATRE FOURCHES BE REMOVED AFTER THE CONTROL STRUCTURE AT THE LITTLE RAPIDS SITE HAS EFFECTIVELY RESTORED WATER LEVELS.

The restoration of water levels in Lake Athabasca to restore former ecological conditions in the Delta presupposes that all of the interconnecting channels within the Delta, with the exception of the Rivière des Rochers, will be left in their natural state. Since the west arm of the Chenal des Quatre Fourches is a major channel between Lakes Claire and Mamawi and Lake Athabasca, the temporary dam should be removed.

THAT THE GOVERNMENTS ESTABLISH A PROGRAM TO PROVIDE LOCAL FISHERMEN AND TRAPPERS WITH BOTH TECHNICAL AND FINANCIAL ASSISTANCE FOR THE PROMOTION OF LOCAL INDUSTRIES, PARTICULARLY WITH REGARD TO OPPORTUNITIES SUCH AS THE DEVELOPMENT OF MUSKRAT FARMING ON SPECIFIC BLOCKS OF MARSHES IN THE CHIPEWYAN RESERVE.

Restoration of the water levels will return the production of muskrats and fish approximately to what occurred prior to 1968. However, improved marsh management and more efficient marketing is required, along with the improved husbandry of trapping and fishing resources, in order to develop these local industries.

THAT THE GOVERNMENTS CONTINUE TO MONITOR THE SPRING SPAWNING MIGRATION OF WALLEYE INTO RICHARDSON LAKE AND CONDUCT FURTHER INVESTIGATIONS, IF NECESSARY, INTO MIGRATORY PROBLEMS CAUSED BY CHANNEL ICE.

The walleye is the mainstay of expanding fisheries operations in Lake Athabasca. Difficulties in walleye spawning could seriously reduce walleye catches and result in loss in income for local fishermen. Preliminary investigations indicate that channel ice could seriously restrict, and possibly block, the walleye migration into Lake Richardson, which appears to be the major spawning area. Some deepening of the channels may be necessary in order to improve access to and from the lake.

THAT THE GOVERNMENTS MAINTAIN A CONTINUING RESOURCE-MONITORING PROGRAM FOR LAKE ATHABASCA AND THE DELTA, UNDER THE GUIDANCE OF THE SENIOR INTERGOVERNMENTAL COMMITTEE.

Project studies indicated that there was a very limited amount of information available on many of the important aspects of Lake Athabasca and the Delta. A continuing resource-monitoring program is required to compile the data, essential in obtaining a full understanding of the complex interrelationships of the hydrologic and biological processes and to provide some predictive capability for planning and decisionmaking.

THAT ENVIRONMENTAL IMPACT STUDIES BE CONDUCTED ON LAKE ATHABASCA, THE DELTA, AND THE SLAVE RIVER, PRIOR TO ANY CONSTRUCTION OF MAJOR RESERVOIRS, DIVERSIONS OR OTHER WORKS THAT MAY BE PROPOSED IN THE LAKE ATHABASCA DRAINAGE BASIN.

The impact of the Bennett Dam development on the Peace River flows, and consequently Lake Athabasca, points out the need for careful consideration of the downstream effects in the planning for major projects. Other major developments in the Basin can be expected to occur in the future. At this time there are proposals for major industrial developments and possible diversions which could, because of their particular nature, have an important effect on the Delta area. Their impacts should be assessed before implementation.

THAT THE GOVERNMENTS EXPAND CONSULTATIONS WITH LOCAL PEOPLE AND WORK TOGETHER TO DEVELOP IDENTITY GOALS, EMPLOYMENT AND LEADERSHIP, AS THESE MATTERS RUN CONCURRENT WITH OTHER ENVIRONMENTAL CONSIDERATIONS.

Restoration of water levels alone will not solve the critical unemployment problem which exists in the area. Particularly in Fort Chipewyan, the maintenance of the traditional trapping and fishing will not provide the opportunities and jobs necessary for the expanding labor force. Positive government action in the form of local consultation and the development of new projects, including those identified by the Peace-Athabasca Delta Project, is required.

THAT THE DATA COLLECTED FOR THE PEACE-ATHABASCA DELTA PROJECT BE MADE AVAILABLE TO THE SCIENTIFIC COMMUNITY TO ENCOURAGE SCIENTISTS TO CONTINUE THOSE STUDIES WHICH ARE IMPORTANT TO THE DEVELOPMENT OF THE NORTH AND TO THE BETTERMENT OF ITS INDIGENOUS PEOPLE.

The wealth of scientific data collected for the Project could be of assistance to universities and other organizations carrying on research programs. Additional research is required on many of the aspects investigated under the Project, such as the social and economic problems of small northern communities and the effects of changes in flows on river and lake ecology.

in conclusion

BENNETT DAM

The Bennett Dam is a development of major proportions. Its presence is now a fact, almost impossible to change. Its builders were answering the needs of society for power to support our economic growth and light our homes. Little attention was given to the possible effects on downstream ecology, for the environment concerns of the seventies were only then beginning to appear on the horizon.

ENVIRONMENT

Experience is a firm teacher; the lessons are clear. Major developments, if not properly planned, can greatly change our renewable resources of land and water, two of our greatest heritages. Planners must find new ways to balance development and the protection of our environment. This is the challenge.

MANAGEMENT

When it is considered that the Mackenzie River System of which the Peace-Athabasca Delta is a part, is the largest in Canada, second in length and greater in flow than the Mississippi River, the wisdom of making strong provisions for its stewardship may be seen.

THE JURISDICTIONAL FRAMEWORK

The Peace-Athabasca Delta problem carries an important message. Poorly defined jurisdiction leads to poorly defined responsibilities. Decision and action for the management of our natural resources become lost in a maze of discussion and red tape. Without a more appropriate framework, the possibility of future problems such as occurred in the Delta still exists. The key lies in a framework within which positive action can be readily taken, one in which local problems are dealt with locally, regional problems — regionally, and national problems — nationally. The onus rests on government at all levels.



PHOTOGRAPHY

L. Allison
J. Card
E. Hennan
G. Townsend
Ducks Unlimited (Canada)
Province of Alberta
Province of British Columbia
British Columbia Hydro
Canadian Armed Forces
Canadian Wildlife Service

MAPPING

Alberta Department of
Highways and Transport,
Mapping Office

AERIAL MOSAICS

Alberta Department of
Highways and Transport,
Planning Branch

Bulletin Commercial
PRINTERS EDMONTON
LITHOGRAPHED IN CANADA



ERINA

In the wisdom gained lies our future.